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DAM AT LAKE ELEANOR, PART OF THE HETCH HETCHY WATER SUPPLY SYSTEM OF SAN FRANCISCO

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San Francisco's Hetch Hetchy Water Supply

PART I

Sites for Three Reservoirs Including Tributary Watersheds Will Have an Area of 652 Square Miles—Construction Planned to Extend Over a Number of Years

By NELSON A. ECKART* and LESLIE W. STOCKER†

THE WATER supplies of the earliest communities were springs, rivers and lakes beside which the people had made their habitations. The next step, as inhabited areas spread, was the sinking of wells, to overcome the inconvenience of going long distances to get water from the surface sources.

As the primitive villages and trading centers developed into the towns and cities of the ancient civilizations, in many cases the water from such sources became so inadequate in quantity or so polluted as to make it necessary to increase or improve the supply by bringing water from distant points.

Many features of our modern city water supply systems were used by the engineers of two or three thousand years ago. Storage reservoirs were formed by building dams. Smaller reservoirs were sometimes constructed at the intakes or along the routes of the aqueducts ,to clarify the water by sedimentation. Water was brought through hills in tunnels, and valleys were occasionally crossed by means of inverted siphons, though on account of lack of suitable materials and processes for manufacturing large pipes that would withstand considerable internal pressures, masonry aqueducts supported on masonry arches were generally used to traverse low ground.

Many of the ancient aqueducts have survived to this day, and some are still in use as parts of the water works of modern cities.

The men who planned and executed these works deserve rank in the engineering profession with the chief engineers of the great construction projects of our own times, for their accomplishments are equally noteworthy when we consider the limitations under which they worked. Where precedent was lacking, judgment was the only guide in design.

THE HETCH HETCHY system is one of the notable modern engineering undertakings of the present day, and it will supply, when completed, 400,000,000 gallons of water daily to a population of 4,000,000 in San Francisco and other cities of the metropolitan district. In addition, this water will generate 200,000 continuous horsepower for use in the development of the industrial and agricultural regions surrounding San Francisco.

Owing to the nature and scope of this huge project and to the essential part played by compressed air in its execution, it is necessary to publish this description in serial form in order to present to our readers a comprehensive description with the necessary accompanying maps, charts, and other illustrations.

This is the first of the series to be published in Compressed Air Magazine, in which will be included complete details of the methods, materials, and machinery used in the accomplishment of this project.

The muscular energy of men and animals was the only form of power available for building the remarkable structures of ancient times, and none but the simplest mechanical appliances, such as the windlass, the inclined plane and the pulley, were known. The most primitive means of transportation were employed, light loads being hauled in ox carts or on sleds, and heavy weights on rollers. Many thousands of prisoners, slaves, or even free men forced to give part of their time to the public works, toiled for years to accomplish what in modern times would be done in a few months by a moderate sized force of men equipped with the construction machinery of the present day.

A striking example of the contrast between ancient and modern methods is in the construction of tunnels. The laborers on the Roman aqueducts might build a fire against the tunnel face, then shatter the rock by throwing cold water against the heated surface. In a limestone formation, vinegar might be used instead of water. Artificial ventilation was unknown, and the effect of this practice upon the workmen's health can be readily appreciated. A sentence to labor in the Roman tunnels was one of the most severe penalties that could be inflicted upon a prisoner or slave.

Another method of excavation was to chisel a channel around a block, then break out the block by means of bars and wedges. Ten or fifteen feet a month must have been very rapid progress in tunneling through any rock that could not be excavated with picks and bars.

In contrast, our modern miners, armed with their compressed air drills and their nitroglycerin powder, make more progress in a day than the ancients did in a month.

The first Roman aqueduct was built about 312 B. C., by the same Appius who built the Appian way. In 226 A. D., the twelfth was completed. The total length of the twelve was 346 miles, of which 44 miles were carried on arches. The range in length was from six to 61 miles. The water was delivered into small reservoirs or tanks, of which there were many scattered throughout the city. Only the most wealthy citizens could afford the luxury of individual services direct to their homes.

The same reaching out farther and farther for water is a feature of the growth of many

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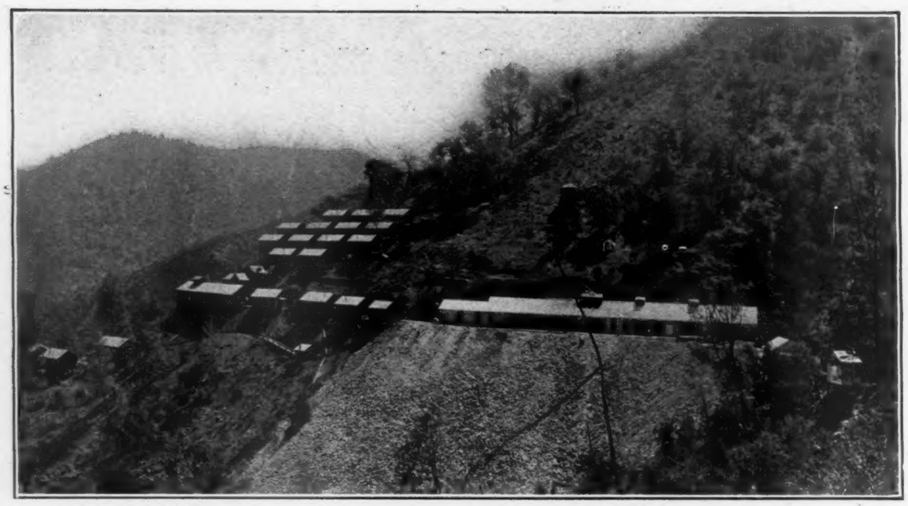
Big Creek camp. This is typical of the construction camps of the Hetch Hetchy project.



Camp at Adit 5-6. The long white building contains the blacksmith shops, compressor plant, blowers, and repair shops. The camp quarters and mess house are to the left.

Hetch Hetchy dam site, looking downstream, August 15, 1921. Excavation for foundations practically completed and preparations being made for pouring concrete. Large pieces of rock stored on convenient ledges, to be used as "plums" in cyclopean masonry. The maximum depth of excavation is 118 feet below the original stream bed. The foundation is solid granite.

modern cities. San Francisco started at the spring and well stage, the water being distributed in barrels from wagons. By gradual steps the water works were expanded, until at the present time the most distant structures in use are about 50 miles from the city along the conduit lines.

San Francisco's Present Water Supply

The city's earliest water supply system worthy of the title was built by a company called the San Francisco Water Works, and was first put to use in 1858. The water of Lobos Creek, a small stream draining the northwesterly section of the present city, was brought through a flume to a pumping station on the bay shore and was raised to a reservoir on a hill, from which it was distributed through a pipe system. The use of Lobos Creek water was discontinued in 1893, on account of the contamination due to increasing population in the districts from which the creek derived its flow.

A second company, the Spring Valley Water Works, began operations in 1860. It later consolidated with the San Francisco Water Works, and, under the name of Spring Valley Water Company, is still supplying water to the city.

The first Spring Valley supply is still in use. An earth fill dam was constructed on Pilarcitos Creek, in the mountains of San Mateo County, south of San Francisco, forming a reservoir from which a 32-mile flume conveyed water to the city. This development was completed in 1862. Additional dams and steel pipes were constructed from time to time until the sources on the San Francisco peninsula were developed to their economic limit, about 15,000,000 gallons daily.

The next step was to Alameda Creek, across the bay of San Francisco. The greater part of the present supply comes from this source which is capable of increased development sufficient to meet the growth of the demand for water for ten years or more.

The Spring Valley supply at present totals about 36,000,000 gallons daily, and its limit is estimated by the city engineer of San Francisco at about 60,000,000 gallons daily. To develop this quantity, the Calaveras dam, now partly completed, must be finished and additional conduit capacity must be provided.

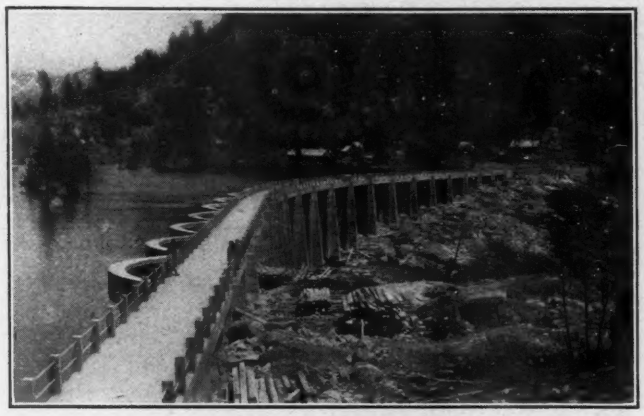
The Hetch Hetchy System

For many years it was apparent that the Spring Valley supply could not be increased indefinitely, and that the growing city must eventually resort to the Sierra Nevada Mountains for a water supply of larger capacity. In 1901 the upper Tuolumne River was chosen by the municipal authorities as the source of the future supply, and after a great deal of controversy with the Government authorities who controlled the Yosemite National Park the city in December, 1913, secured a Congressional grant of the necessary rights in the public lands of that region and was free to begin construction.

The project is known as the Hetch Hetchy Water Supply. It is named for its principal reservoir site, Hetch Hetchy Valley.

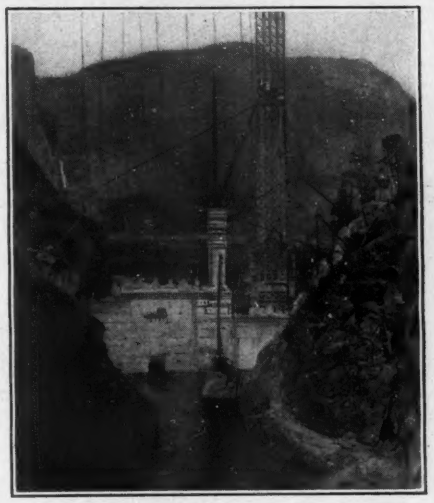
The new system was selected and designed with a view to being developed ultimately to

The Tuolumne River above Early Intake, April 28, 1922.

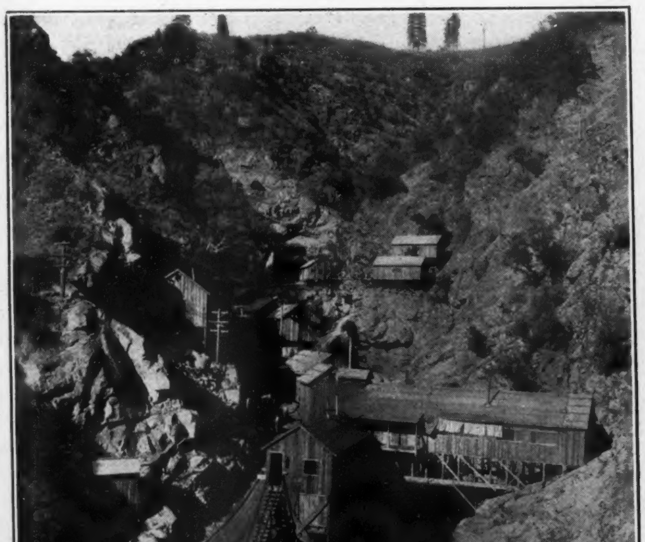


Lake Eleanor dam completed, with reservoir full, May 8, 1919.

The site of Hetch Hetchy dam, previous to commencement of construction, looking upstream into Hetch Hetchy valley from a point just below the dam site. The rock walls in the background are 2,300 feet high.



Hetch Hetchy dam, April 24, 1922. View looking upstream. The top of the concrete elevating tower is 380 feet above the water level.



Camp at South Fork tunnel portal. The canyon walls here are very precipitous and a great deal of ingenuity was required in laying out the camp. The mess house spans the river.

Early intake power plant, storage flume and 42-inch pressure pipe. This plant furnishes all the electric power used for construction purposes on the Mountain Division of the project.

Pouring concrete in Hetch Hetchy dam, November 20, 1921. Contraction joint in right foreground, upstream face of dam at left. Drainage wells and inspection wells built of precast concrete blocks. Face of dam finished with cement gun.

Hetch Hetchy dam site, August 18, 1921. View of south abutment, showing cut-off trench and stepped form of excavation. Concrete hoist tower to left and bulk cement storage bin above.

furnish 400,000,000 gallons of water daily to a population of 4,000,000 in San Francisco and the other cities of the Metropolitan District in the region of San Francisco bay. This will take care of the increase of population for a century to come, according to present estimates.

In addition, this water on its way to San Francisco will pass through several large power plants, generating the equivalent of 200,000 continuous horsepower, which will materially assist in the development of the industrial and agricultural regions of which San Francisco is the financial center.

The Catskill Water Supply development of New York City, and the Metropolitan Water Supply system of Boston and the neighboring cities, are similar in general characteristics to the Hetch Hetchy, except that they generate no power. They are the only comparable systems in the United States of a magnitude equal to or greater than that of the Hetch Hetchy project.

General Description of the System

The accompanying map and profile show the general character of the Hetch Hetchy system, from the sources of supply to the terminal reservoir in San Francisco.

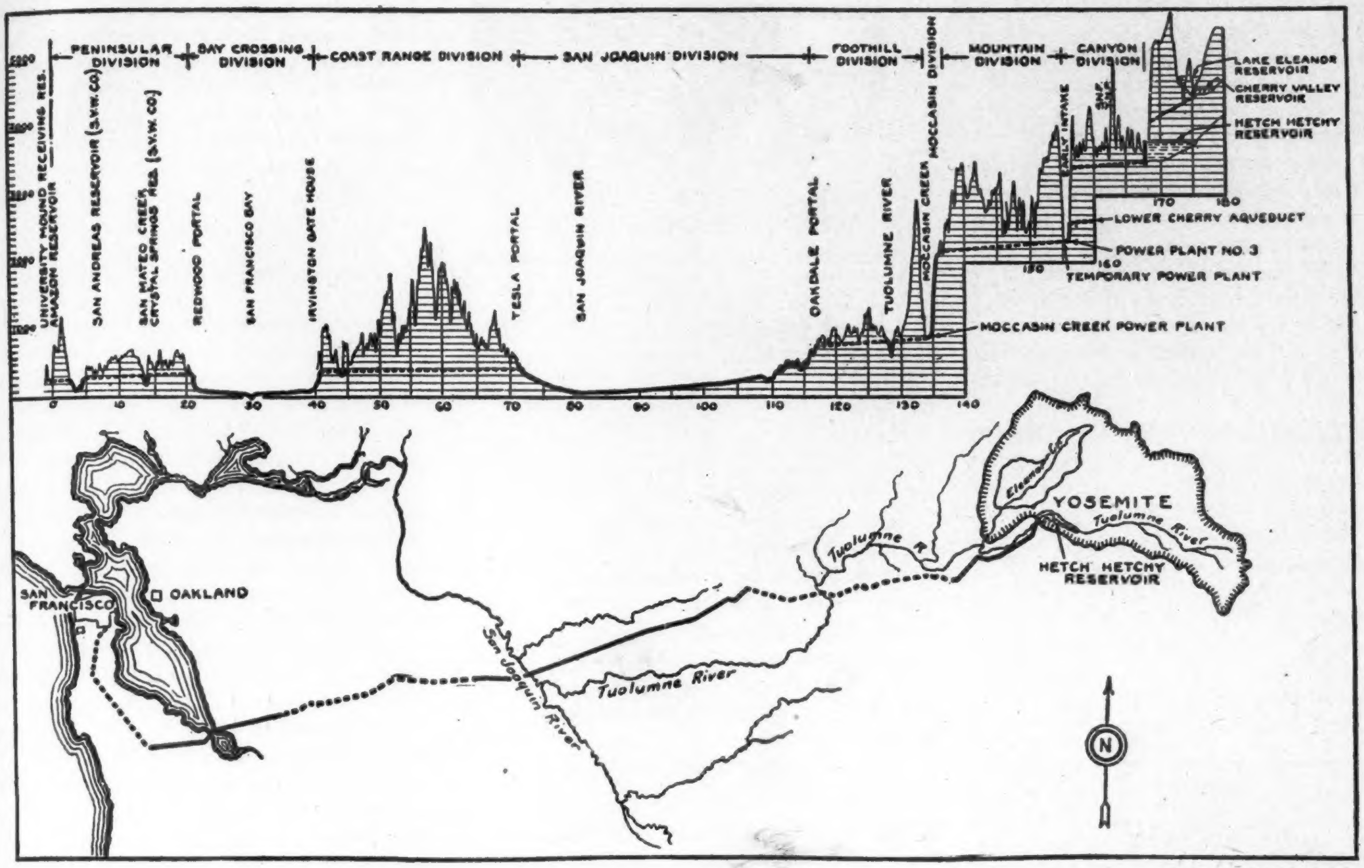
The city has, by Congressional enactment and by purchase of privately owned lands and rights, secured three reservoir sites, Hetch Hetchy, Lake Eleanor and Cherry Valley, which together will have a storage capacity of 570,000 acre-feet, with tributary watersheds totaling 652 square miles. This area lies at elevations from 3,500 to 13,090 feet above sea level, 92 per cent. being above 6,000 feet. The watersheds are visited only by summer tourists and camping parties, and the city has the right to enforce sanitary regulations, thus insuring the permanent purity of the water supply.

In passing, it may be noted that although the watersheds lie mostly within the Yosemite National Park, the city's plans will not in any way affect the Yosemite Valley, which lies in the basin of another river, the Merced, and covers only a very small fraction of the Park area.

The headworks of the main aqueduct are located twelve miles down the Tuolumne River from Hetch Hetchy dam, at 2,340 feet elevation. This point is called Early Intake. It is nearly 1,200 feet lower in elevation than Hetch Hetchy Valley, and more than 2,000 feet below the other reservoirs. The utilization of these drops for generating electric power is a matter of future development.

From the Early Intake diversion dam, a sidehill conduit half a mile in length will bring the water to the east end of a tunnel 18.3 miles long, terminating at the Priest reservoir, which is to be the forebay reservoir for the Moccasin Creek power plant. The spillway here will be at elevation 2,240 feet. This stretch from Early Intake to Priest reservoir is known as the Mountain Division of the aqueduct.

The conduit from the Priest reservoir to the power plant will consist of 5,900 feet of tunnel, thirteen feet in diameter, and several very heavy steel pipe lines 4,900 feet long, one pipe line for each of the hydro-electric gen-



Profile and plan of the Hetch Hetchy water supply system, by which 400,000,000 gallons daily will be brought from the Yosemite to San Francisco and adjacent districts.

erating units. The plant is in the direct line of the main aqueduct, and will receive an average flow of 620 second-feet (400 million gallons daily) and discharge it into the lower section of the aqueduct. This flow, with a gross drop of 1,315 feet, will enable the plant to generate an average of 52,500 kilowatts, or 70,000 horsepower. The ultimate installed capacity, however, may double these figures, as this is to be the regulating plant for the whole power development of the project, and the daily variation of load on the plant between the minimum and the maximum may cover a very wide range. The unusually large forebay capacity, 2,500 acre-feet, and the lack of forebay sites for the upper power plants, make this scheme for regulation at Moccasin Creek advisable. The initial installation will comprise four 17,500 kilowatt generators.

The next section of the aqueduct, the Foothill Division, will cover another seventeen miles of tunnel, extending through the Sierra Nevada foothills to the east side of the San Joaquin Valley.

The valley is to be crossed with (ultimately) three parallel lines of steel pipe, each nearly seven feet in diameter and 45 miles long. For over 30 miles of the distance, the head on the pipes will be 450 to 540 feet. Long lines of pipe under such high pressure are unprecedented in water works construction.

Next comes the tunnel through the Coast Range, 31 miles long, ending at Irvington gate house. From this point the water will be distributed to the three principal divisions of the Metropolitan District through three divergent branches: the principal one, of 200 million gallons daily capacity, going west to the San Francisco peninsula: the second, northwest to Oakland and the other "East Bay Cities," and the third southerly to San Jose and the Santa Clara Valley.

We are still over 40 miles from San Francisco. This distance will be traversed by pipes and tunnels, and connections will be made to the reservoirs of the existing Spring Valley water supply system, so that these reservoirs, which are already large but are capable of being doubled in capacity, will serve to store Hetch Hetchy water close to the city, safeguarding the supply in case of a break in the long conduit line from the mountains. A connection will also be established near Alameda Creek, so that the additional water from that source can be conveyed in the Hetch Hetchy aqueduct, thus avoiding the waste due to duplication that would otherwise be necessary to utilize this water.

M. M. O'Shaughnessy

Member American Society of Civil Engineers and city engineer of San Francisco since September, 1912, under whose direction the Hetch Hetchy water supply and power development has been and is being carried out.

In the city, a large receiving reservoir, with a capacity of 300,000,000 gallons or more, is to be built at about 248 feet elevation, from which about half of the ultimate supply can be distributed without pumping.

The system is a gravity one from the mountains clear down to San Francisco.

Order of Development

The additional water supply now being developed from the local sources (Calaveras Dam) will carry the city on for the next ten years, and it will not be necessary to deliver Hetch Hetchy water to the city prior to that time. The plan adopted, therefore, was to build first the Hetch Hetchy dam, the Mountain Division of the aqueduct, and the Moccasin Creek power plant, and put the water to work at the earliest possible time generating power, the sale of which will bring in a revenue which will be applied to lighten the burden of taxation for interest and bond redemption charges. This con-

struction work is under way, and will be completed in about two years.

The aqueduct between Irvington and San Francisco will soon be under construction. This is to be used at first to bring in the additional Calaveras supply, as already mentioned.

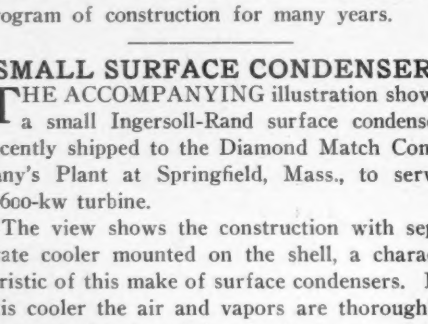
The connection between Irvington and Moccasin Creek will then be undertaken, and will be completed in time to have the Hetch Hetchy water on hand when needed.

The additional dams, power plants, and parallel pipe lines will be installed one by one, as the demands for water and power increase, so that there will be a more or less continuous program of construction for many years.

SMALL SURFACE CONDENSER

THE ACCOMPANYING illustration shows a small Ingersoll-Rand surface condenser recently shipped to the Diamond Match Company's Plant at Springfield, Mass., to serve a 600-kw turbine.

The view shows the construction with separate cooler mounted on the shell, a characteristic of this make of surface condensers. In this cooler the air and vapors are thoroughly devaporized before being finally drawn off by the vacuum pump equipment.



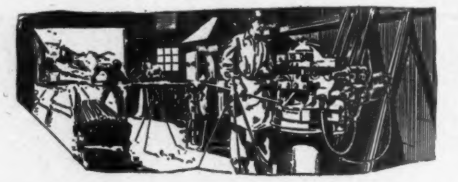
Surface condenser showing primary jet mounted on the cooler.

Air is withdrawn by a steam jet vacuum pump in combination with a small secondary reciprocating pump. The primary steam jet is mounted on the cooler dome and the secondary jet on the tee shown. The secondary vacuum pump takes its suction from the open end of the tee.

The condensate and circulating water pumps are Cameron centrifugal motor driven units.

A LONG TRAIN OF COMPRESSED AIR PRODUCT

ONE OF the largest single shipments of finished stone ever made in this country, or probably in the world, was sent recently from Bedford, Ind., to Harrisburg, Pa. It comprised the entire installation of 36 monster monolithic columns of Indiana limestone for the new Pennsylvania State Office Building. Each column is 33 ft. 8 in. long, 4 ft. 9 in. in diameter, weighs 48 tons and is valued at $7,500, making the total value of the shipment $270,000. This record shipment is unique in another respect, in that it is entirely the product of compressed air tools, channelers and rock drills having cut each block from its native bed while pneumatic tools did the shaping and finishing.



DRILL STEEL—BITS AND SHANKS

[Drill steel has always been a much discussed subject and it probably will continue to be as long as there is rock to drill and blast. We are continually receiving letters asking for advice on various phases of this subject. Most of these questions and their answers are of interest to a large part of our readers, and therefore this column is published in order to give our readers the benefit of the service that we have been rendering through this correspondence. Questions are especially invited which have to do with any phase of forging, tempering and the care of drill bits and shanks. Our answers, based on the best modern practice, will be published in succeeding issues.—ED.].

COMPRESSED AIR MAGAZINE,
New York City.

Dear Sir:—I am drilling in ground which varies from a soft disintegrated rock to trap rock. The steel does not stand up and I would like to have you outline the correct methods of dressing and tempering steel for this work. Our blacksmith will be glad to try out your suggestions.

Yours very truly,
Los Angeles, Calif. J. W. R.

To some extent this question has been answered in these columns in recent issues. The bits should be made sufficiently hard to drill the hardest rock that will be encountered; it will then take care of the softer rock. The forging temperature should be about 1,900 degrees Fahrenheit and in tempering, we recommend that the steel has a temperature of about 1,440 degrees at the moment it is plunged into the tank. The distance back from the bit along the bar that the forging and tempering heats should be carried was discussed in the July issue of COMPRESSED AIR MAGAZINE.

We assume that you are dressing your bits by hand which may lead to a number of troubles. The cutting edge should be straight. There is a frequent tendency to get the edge crooked, i. e., higher on one end than on the other, which results in the force of the blow of the hammer being exploded on the high end and causing breakage. The cutting edge should be carried out even the full length, the wings made symmetrical, and reaming edges brought out correctly. Care should also be exercised in dollying the bit to see that an even blow is struck so as to prevent bending the steel from one side to the other, thus causing strains to be set up which cannot be relieved by subsequent heat treatment. The use of a drill sharpening machine eliminates most of the usual drill steel troubles. It will often be found a paying investment to install such a machine even where only one or two rock drills are being used.

COMPRESSED AIR MAGAZINE,
New York City.

For many years I have been using all kinds of tanks for tempering drill steel and have seen a good many queer-looking ones. Sometimes we use a tank made from any old lumber left over from some other job and often I have seen half of a barrel used for this purpose. I really think that if some one took the time to work out a design for a tempering tank which would be made for the purpose for which it is to be used, a great deal of time would be saved in tempering and much better results would be had. Will you let me know your ideas on this and how you would make a tank?

Yours very truly,
Houghton, Mich. M. V. M.

This question is a very practical one. We consider a properly designed drill steel tempering tank very important. The tank should be rectangular in shape with a minimum area of six square feet and a depth of not less than one foot. The size of tank of course depends upon the amount of steel handled. For large shops a much bigger tank is recommended.

The tempering water should circulate. The water should not flow over the edge but through an outlet below the upper edge, and should be admitted at the bottom of the tank. On two opposite sides there should be a rack with slots in which plugs may be placed to support a perforated steel plate. This plate may be placed about ¾ in. below the surface of the water by adjusting the plugs in the proper slots. The drill steels are plunged into the water and rest vertically on this grating, thus giving a submergence of ¾ in. which is the average for the "run of mine" steels. However, for smaller size bits perhaps a lesser amount, say ½ in. would be better and for larger diameter bits a greater degree of submergence would be better. This can be easily adjusted by the plugs in the slotted rack.

COMPRESSED AIR MAGAZINE,
New York City.

Dear Sir:—I am having a whole lot of trouble with my drill steel and have been trying to find out just what is the cause. The shanks instead of being tough are brittle and I think the trouble is in the quenching which we do in oil. Will you please tell me the best method of quenching in oil and exactly what kind of oil I should use?

Yours truly,
Baltimore, Md. S. V.

You should use a good grade of soluble quenching oil, a number of brands of which can be obtained on the market. We suggest that you consult the local agents of the best oil companies. If an oil of inferior quality should be used, it will become thin very quickly which has the effect of quenching the steels too rapidly; or in other words, it has to some extent the same effect as if the steel was quenched in water. The correct quality of oil will have a comparatively slow tempering effect.

It has also been found that water often gets into the oil tank; it naturally collects at the bottom. The tank should have a bottom drain so that such water can be drawn off frequently. Arrangements should be made to cool the oil if it is in frequent or continuous use. Otherwise the temperature of the oil will soon become too high to properly temper the steel.

Enameling Large Steel and Iron Containers

Compressed Air is a Prime Aid in This Youthful American Industry—The Use of Enamel Ware as a Container for Food Products is Rapidly Extending

By ROBERT G. SKERRETT

JUST AS the mounds of kitchen-midden in Scandinavia, Scotland, and Ireland have revealed much of the domestic habits of the peoples of ages gone, so, too, will the enameled steel and iron, which may be found centuries hence in our own scrap heaps, disclose something of our standards of life to the generations of men that may follow us.

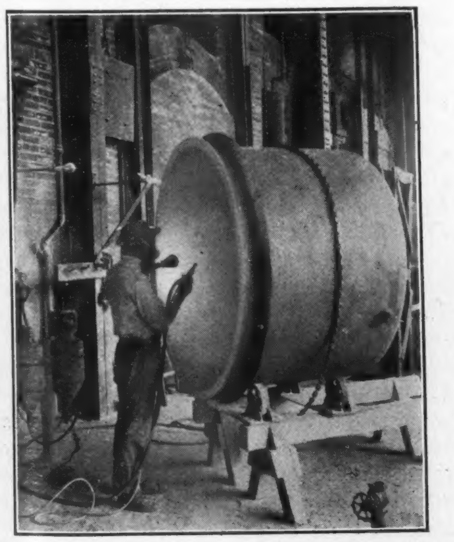
It may not be generally known, but prior to 1914 we relied in large measure upon France and Germany for certain indispensable enameled apparatus. In truth, well-nigh all of our cast-iron equipment so coated to resist the attack of acids, and used extensively in plants devoted to the manufacture of chemicals, drugs, etc., were imported; and for this reason we were hard put to it, when the World War cut off or reduced those sources of supply until manufacturing facilities were created.

To the average person, enameled ware represents the familiar array of culinary utensils. Important as these undoubtedly are to our convenience and well being, they are, nevertheless, only a part of the total tonnage of enameled products turned out here or needed by us in the course of each twelve month. This becomes evident when we consider for a moment the immense quantities of canned soups, vegetables, fruits, and other foodstuffs which are put up by us annually for home and foreign consumption, and in the preparation of which care must often be taken to prevent contact with metal surfaces. The condensed milk and the ice-cream industries of America are on a vast scale, and here, likewise, it is dangerous to employ uncoated metal vessels. In these businesses there is a big demand for enameled steel and iron ware. Finally, let it be said that there are numerous other lines of productive activity in which large enameled kettles, stills, vacuum pans, condensers, etc., are required.

ENAMELED ware, aside from its use in familiar culinary utensils, is an important factor in the preparation of the immense quantities of canned foodstuffs annually consumed.

Enameled kettles, stills, vacuum pans, condensers, etc., are required in many of the processes in which it would be dangerous to use uncoated metal vessels.

The enamel ware industry in this country, developed to its present plane from the exigency of wartimes, employs interesting methods and processes in which compressed air has many important applications.



A comprehensive view of an enamel-spraying station. The small cone-bottomed tanks back of the operative contain the enameling fluid.

To understand how enamel-lined apparatus are manufactured, let us follow the methods adopted by a typically up-to-date establishment, such, for instance, as the Elyria Enameled Products Company, of Elyria, Ohio, which is one of the pioneers in this new field of endeavor. At the start, it should be pointed out that enamels of different compositions are used in the treatment of steel and of cast-iron; and, further, that the make-up of the so-called "ground coat" is unlike that of the "cover coat" or finishing coat. To a considerable extent, the service for which the commodity is designed, rather than the characteristics of the structural metal, determines the nature of the protective film.

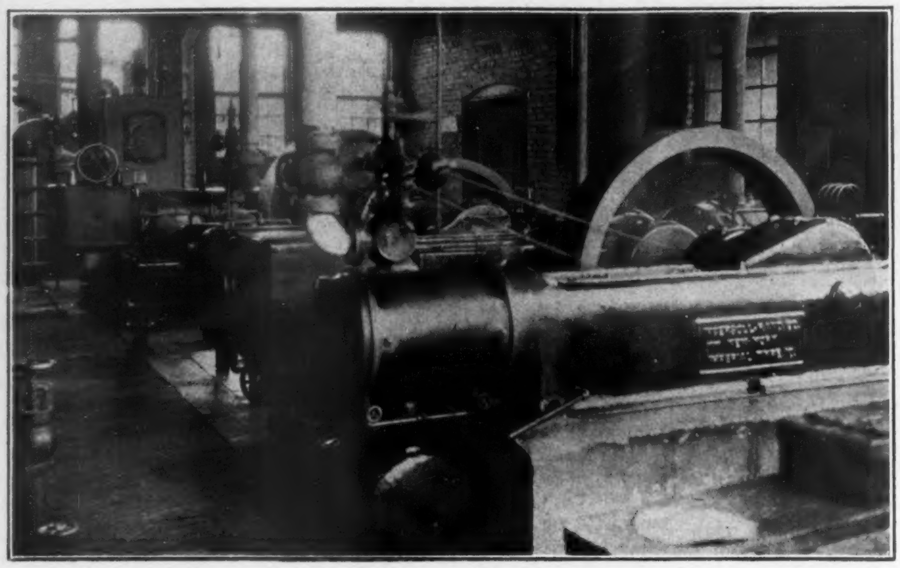
At the Elyria plant, the cast-iron and the steel products are handled in separate departments. Enameled steel equipment is made of basic open-hearth steel which does not carry more than 0.15 per cent. of carbon, because steel of a higher carbon content is apt to induce blisters in the enamel. The castings are of dense, gray iron of a superior order. Whether the enamel is to be applied to steel or to cast iron, its preparation embraces three stages—i. e., mixing, smelting, and grinding. For the information of persons who may be curious about the materials which enter into enamel batches, the table on page 214, furnished by Emerson P. Poste, a recognized authority, is reproduced:

A raw batch may be mixed by shovel, much after the fashion of dealing with small quantities of concrete, or the ingredients may be run through a mechanical mixer if the amounts are large enough to warrant this. When the batch has been thoroughly combined, it is placed in a reverberatory smelting furnace, and there the mix is melted. The fused materials are then drawn off and led into a trough filled with cold water. This sudden chilling induces a shattering action which breaks up the vitreous substance into a comminuted mass, known to the trade as "frit." The ultimate composition of this frit is contingent upon the extent to which the smelting is carried; and care must be exercised lest an excess percentage of some of the constituents be volatilized while the batch is in the furnace.

Not all batches are fused in the manner just described. For instance, the raw materials for a certain kind of ground coat for cast iron are, after mixing, put in a cast-iron tray where they are brought to a bright-red heat instead of being melted. The resulting cindery agglomeration suggests pumice stone; and this, unlike frit, has to be crushed before grinding. The grinding may be done by either a wet or a dry method. As a rule, the wet process is employed in preparing both coats for the enameling of steel but only the ground coats for cast iron. Cover coats for cast iron are ground dry.

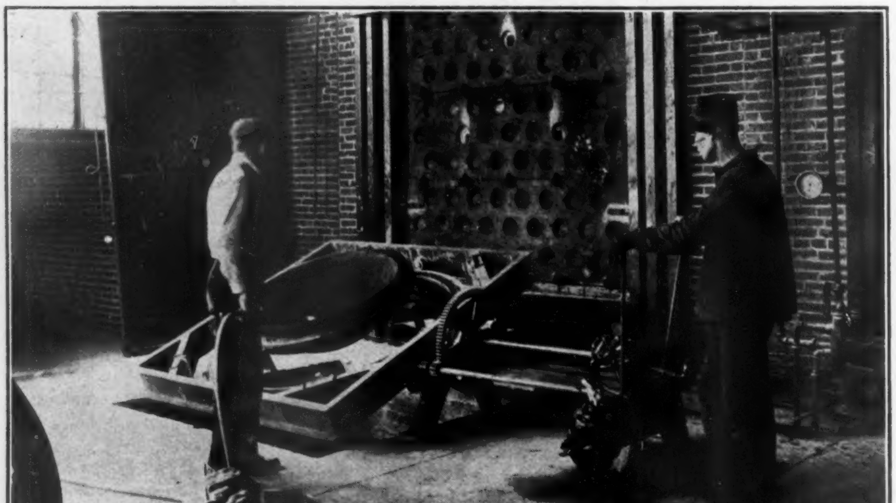
The end sought in grinding is to insure a suspension of the minute particles of enamel so that the latter may be handled virtually as a liquid. This is achieved by grinding the frit, for example, in a pebble mill in combination with a prescribed measure of water and mill additions. Among the latter is clay, which possesses the property of suspending the pulverized enamel and further lends itself to a treatment, called "setting up," by which the sta-

After chipping contiguous edges with an air tool to make a good fit, the neighboring parts are welded by oxy-acetylene flame.

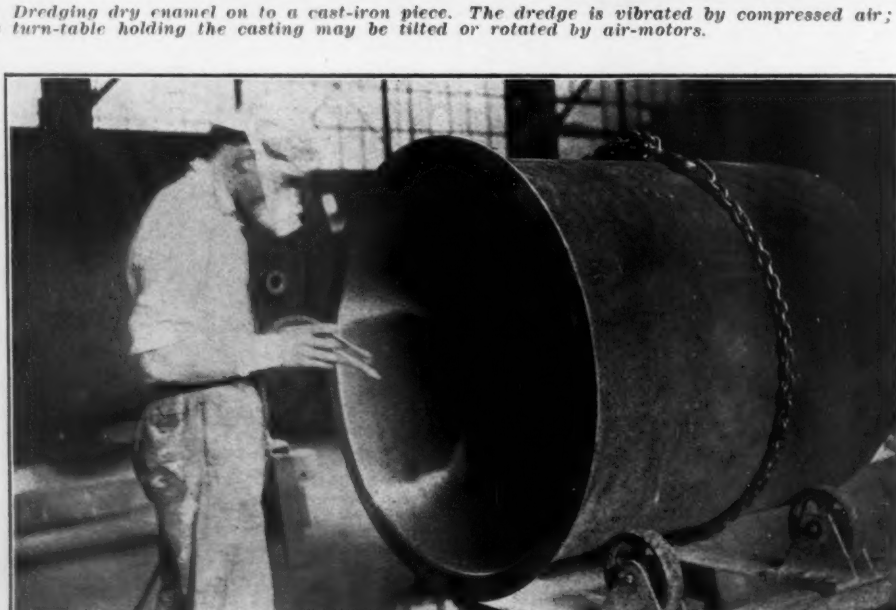


Photos, Courtesy, The Elyria Enameled Products Co.

Compressed air for the plant is supplied by two compressors. The one furnishing air for sand blasting has a capacity of 1200 cubic feet per minute at a pressure of 40 pounds per square inch. Air at a pressure of 90 pounds per square inch for other purposes is supplied by a compressor having a capacity of 450 cubic feet per minute.



Dredging dry enamel on to a cast-iron piece. The dredge is vibrated by compressed air; and the turn-table holding the casting may be tilted or rotated by air-motors.



A close-up of a worker spraying enamel on to the surface of a cylindrical tank by means of compressed air.

bility of the colloidal compound is greatly increased. While clay is the principal medium used for this purpose, still it does not suffice to prevent settling when the enamel is subsequently diluted to facilitate its application. Therefore, an electrolyte is resorted to; and this induces changes in the physical properties of the enamel constituents so that the consistency of the mixture can be varied over a considerable range without causing settling. The "vehicles" commonly relied upon to do this are borax and magnesium sulphate, depending upon whether the enamel is for a ground coat or a cover coat.

BATCH FORMULAE*

Raw Materials	Steel	Steel	Cast Iron	Cast Iron
	Ground Coat	Cover Coat White	Ground Coat	Cover Coat White
Soda	74	...	...	71
Borax	356	154	288	133
Saltpeter	...	65	16	...
Chile saltpeter	...	...	...	24
Lead oxide	...	...	...	144
Zinc oxide	...	...	...	44
Tin oxide	...	...	...	73
Calcspar	...	65	...	24
Barium carbonate	...	...	...	11
Magnesium carbonate	...	10	...	...
Feldspar	363	386	...	372
Fluorspar	53	13	...	107
Cryolite	...	117	...	...
Quartz	144	190	700	...
Manganese dioxide	6½	...	...	...
Cobalt oxide	2¼	...	...	...

MILL ADDITIONS

Clay	6 %	7%	12%	...
Borax	2½%	...	...	...
Tin oxide	...	12%	...	...
Magnesium oxide.	...	¼%	...	...
Sand	...	...	9%	...

*"Journal of the American Ceramic Society."

It is at times desirable to control the melting point of the enamel during the process of burning it on the metal, and this regulation may be exercised by admixing such refractory materials as silica or feldspar while the enamel is undergoing grinding. Divers substances are employed to produce enamels of different colors; but tin oxide is the customary mill addition for the white enamel seen frequently on cooking utensils.

Now that we have a broad idea of the preparation of the enamels and the function of some of the mill additions, let us, for example, follow the work of fashioning a large steel tank and its subsequent enameling. This tank is intended for milk storage in a condensing plant, and, when finished, will have a height of eleven feet and a diameter of ten feet. Suitable plating is run through a bending roll, after which the cylinder is completed by uniting the longitudinal edges by oxy-acetylene welding. In order that the edges may fit closely before welding, the welder not infrequently has recourse to a pneumatic chipping hammer. The Elyria works have 28 welding stations, and each of these is equipped with a No. 8 oxy-acetylene torch and a pneumatic chipper. The surface to be enameled must be smooth and clean, and the first thing done to this end consists in grinding the weld by means of portable grinders. The next step is that of sand blasting, which clears away any scale or superficial impurities.

The sand-blasting department of the Elyria establishment is said to be of exceptional capacity, and boasts four big sand-blast rooms,

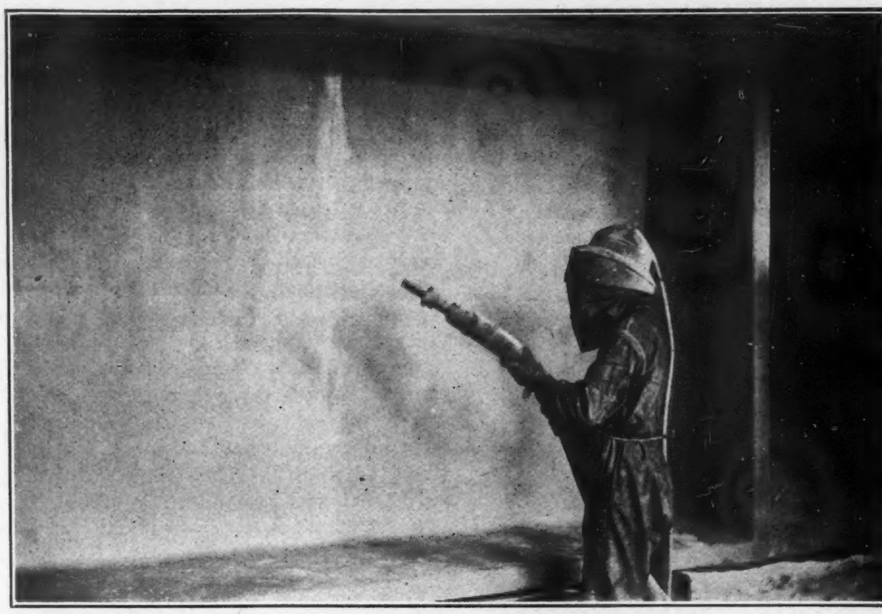
each of which is fifteen feet high and twenty feet deep. Two of these compartments are ten feet wide and the others fifteen feet wide. The air for sand blasting is supplied by a compressor capable of furnishing 1,200 cubic feet of air a minute at a pressure of 40 pounds to the square inch. Compressed air from the same source is fed to the helmets of the sand-blast operators so that they may have an uninterrupted flow of fresh air for respiration. Inasmuch as there are numerous further directions in which compressed air plays its helpful part, the plant has another Type X compressor having a capacity of 450 cubic feet of air per minute at a pressure of 90 pounds to the square inch.

With the completion of the sand blasting the tank is ready to receive its initial or ground coat of enamel, and this is sprayed on by compressed air atomizers.

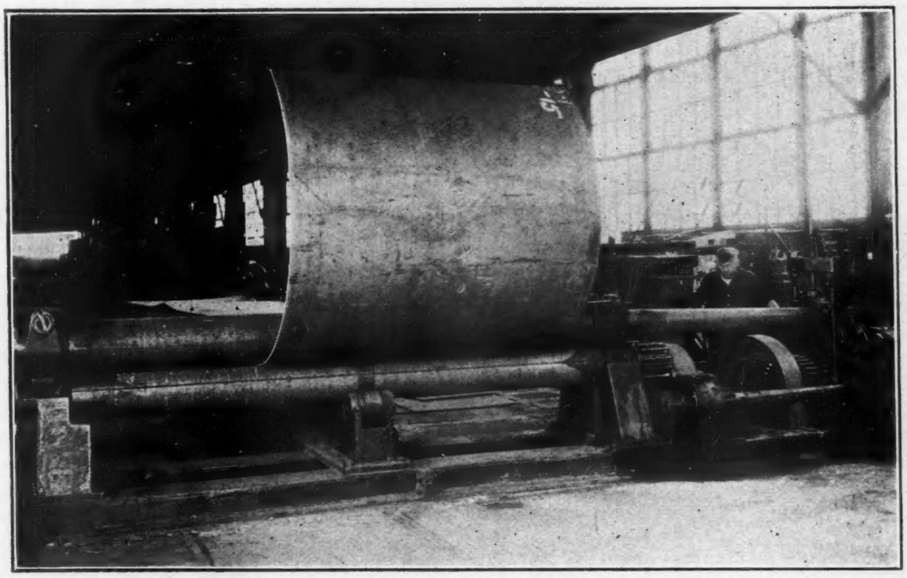
An accompanying illustration gives a general view of a sprayer in action and also pictures two cone-bottomed reservoirs in which the prepared enamel is held severally for the ground and the cover coats. Above the left-hand receptacle is a pressure regulator surmounted by two gages. One section of the regulator maintains a constant air pressure upon the enamel being sprayed while the other section controls the air going to the atomizer. Obviously, the pressure exerted by the air upon the fluid in the container serves to deliver a stream of enamel to the air-gun. Both the ground and the finishing films may be built up of more than one coat, but each of these is burned on in a furnace before the next one is applied.

Previous to burning, a fresh coat is dried. This stage of the work may be hastened by small portable blowers. The burning of large pieces is done in direct-fire furnaces, i. e., furnaces which expose the commodities to the flames or products of combustion; and the temperatures range from 1800 to 2000 degrees Fahrenheit, depending upon the size of the article undergoing treatment and the nature of the coat. That is to say, a given ground coat requires a higher temperature than does the cover coat which overlies it; and wares made of heavy metal must be subjected to higher temperatures than those fashioned of lighter material. The furnaces use liquid fuel; and the oil is vaporized in the burners by low-pressure air which is furnished them by two centrifugal compressors having a total capacity of about 7,000 cubic feet per minute at a pressure of three pounds.

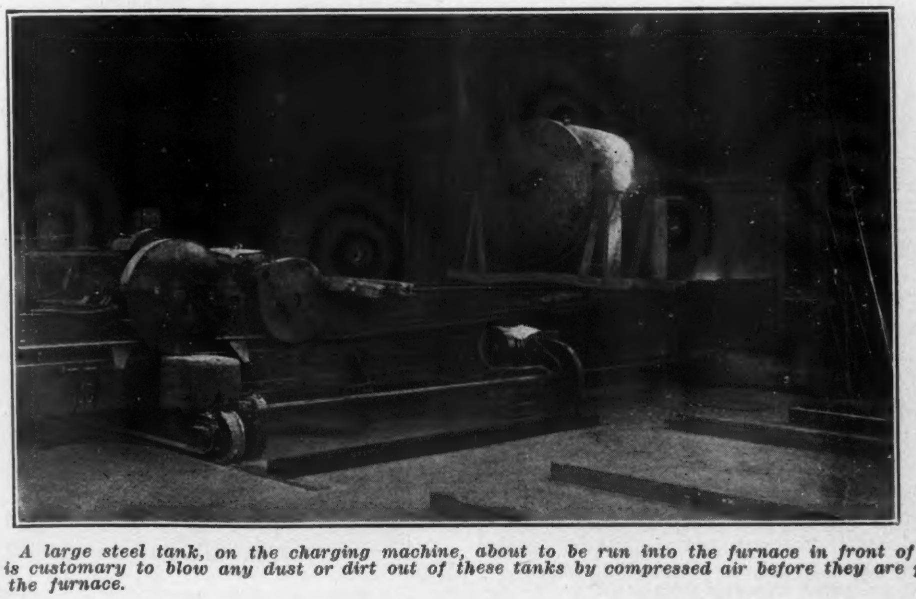
To return to our tank, which we have been following through the shops and whose first coat is dry enough for burning, let us see what takes place when it is dealt with in this department. In preparation for the arrival of the tank, a special burning rack of iron is preheated, and at the right moment this is withdrawn from the furnace. The tank is put upon this rack, and just before it is run into the furnace by an electrically-operated charger the inside of the tank is blown free of any accumulated dust and dirt by a vigorous stream of compressed air. According to Mr. Poste, this is what happens next: "When a piece of ware is placed in the furnace certain preliminary reactions occur, such as the dehy-



Sand blasting the interior surfaces of a rectangular tank. Note the hose connecting with the top of the operator's helmet by which compressed fresh air is delivered to him for respiration.



Bending a big steel plate in forming the body of a large tank which, when enameled and finished, will hold milk in a milk-condensing plant.



A large steel tank, on the charging machine, about to be run into the furnace in front of it. It is customary to blow any dust or dirt out of these tanks by compressed air before they are put in the furnace.

dration of the clay and other mill additions which, in drying, may have retained moisture. The individual particles of the enamel then melt and run together forming the finished surface. After the ground coat has been burned and allowed to cool a cover coat is applied in a similar manner, dried, and burned, and the process repeated until the desired amount of enamel has been applied."* So much for the handling of steel apparatus. With the last coat burned, the piece is ready for the final touches, which may involve attaching supports, piping, pressure gages, valves, etc.

Before we leave this phase of the subject, however, it might be well to point out that the principal things that are apt to lead to the blistering of enamel on steel are laminations and gas pockets in the metal, some types of segregations, and the presence of dirt on the surface. Most of these trouble makers are effectually done away with by sand blasting the steel before enameling it. Should small imperfections appear during enameling, however, these can generally be obliterated by additional coats of enamel; but it is commercially impracticable to deal in this fashion with more serious blemishes. To dispose of the latter the entire coat of enamel is removed by sandblasting; next, the tank is returned to the Tank Shop where the defect in the metal is cut out and an insert of sound steel is welded in place; and, finally, the tank is re-enameled.

And now for the procedure adopted for the enameling of cast-iron ware or shapes. The ground coat is put on with an atomizer, and when this has dried sufficiently the article is carried to a "muffle" furnace—i. e., one in which the products of combustion do not come in contact with the commodity. In this furnace the metal body is heated uniformly until it reaches a bright-red stage. From here on the enameling process is quite unlike that practiced in the case of steel, and is known to the trade as "dredging." The red-hot ware is not allowed to cool when withdrawn from the furnace; but while it is still at a high temperature the enamel is applied dry through the medium of a sieve, attached to a long and hollow handle, which is vibrated by compressed air. This "dredge" shakes the powdered enamel onto the hot surface of the casting which is held, for the time being, on a special turntable. The latter is so constructed that the object being treated can be rotated and tipped up and down to any position. The tilting and rotating motions are effected by compressed air motors.

After a proper amount of enamel has thus been deposited, the piece is returned to the furnace and kept there until the powdered enamel has been fused into a fairly uniform film. Once more the casting is removed from the furnace; another layer of dry enamel is sprinkled upon it; and the burning is repeated. In this manner the enamel is gradually built up to the desired thickness. The final touch consists in subjecting it to a somewhat harder firing than any of the previous ones, and this produces a very smooth and extremely glossy surface. Compressed air is utilized to operate the mechanisms that open and close the doors of some of the furnaces.

As a rule, the enameled cast-iron products are of moderate dimensions compared with those of steel, and include such commodities as shallow dishes and pans, open-top kettles, jacketed or unjacketed, stills, vacuum pans, and digestors. These apparatus are used primarily in the pharmaceutical and the chemical industries in which the stuffs undergoing treatment might be injured if not ruined were they to touch metal.

In conclusion, success in the making of enameled goods depends much upon the selection of the raw materials, and it is equally true that rather nice technical control must be exercised all along the line. At the Elyria plant is maintained a comprehensive laboratory, and this co-operates closely with the sales department of the company. That is to say, the needs of a prospective client are studied in the laboratory before orders are issued to the manufacturing departments; and no productive work is undertaken until the researches give ample warrant for the belief that entire satisfaction can be guaranteed. Indeed, an intimate record is kept of every piece of equipment turned out; and should failure of any sort occur subsequently, the reason for the breakdown can be traced.

*Jour. Amer. Ceramic Society.

WESTERN RESOURCEFULNESS

Many and varied factors often contribute to the making of a record. Ingenuity was shown recently during the construction of the Big Creek power house of the Southern California Edison Company in solving a problem of cutting quickly an enormous quantity of steel used to reinforce concrete according to *Pacific Mining Press.* For this purpose a Leyner drill sharpener was fitted with special dies; it proved so successful that its adoption helped to establish a record in power-house construction work. Resourcefulness of this kind often results in giving manufacturers a valuable hint. The encouragement of initiative in isolated camps should be a feature of managerial policy.

SIMPLE TEST FOR MONOXIDE POISONING

THE DEPARTMENT of the Interior, acting through the Bureau of Mines, has recently made public (Bulletin No. 2356) the results of an investigation which greatly simplify existing test methods. The value and importance of the information is sufficiently evident. Not only does prompt and accurate diagnosis control the treatment of cases, but it affords a means of making just decisions on claims and of eliminating false illusions and complaints from workmen whose ailments may be from other causes.

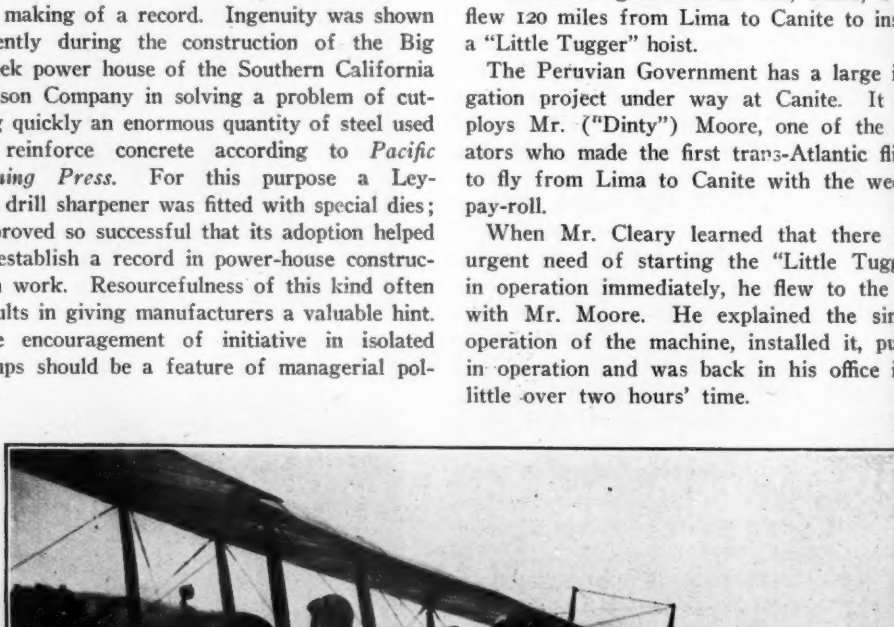
Most cases of carbon monoxide poisoning occur at places—such as garages, around gas and gasoline engines, blast furnaces, after blasting in mines and quarries, after mine fires and explosions, around gas-producer plants and in fact everywhere where there is the possibility of an exposure to the product of combustion of carbonaceous fuel—that are quite distant from laboratories making examinations. The method is based on the use of tannic acid for the quantitative determination of carbon monoxide in the blood and can be used by any person likely to have contact with cases of poisoning. It requires only simple and inexpensive equipment and requires not longer than eight to ten minutes for completion.

FLIES 120 MILES TO INSTALL A "LITTLE TUGGER" HOIST

RECENTLY Mr. F. P. Cleary, representative of Ingersoll-Rand Co., Lima, Peru, flew 120 miles from Lima to Canite to install a "Little Tugger" hoist.

The Peruvian Government has a large irrigation project under way at Canite. It employs Mr. ("Dinty") Moore, one of the aviators who made the first trans-Atlantic flight, to fly from Lima to Canite with the weekly pay-roll.

When Mr. Cleary learned that there was urgent need of starting the "Little Tugger" in operation immediately, he flew to the job with Mr. Moore. He explained the simple operation of the machine, installed it, put it in operation and was back in his office in a little over two hours' time.



Airplane which carried F. P. Cleary 120 miles to install a "Little Tugger" hoist.

Pneumatic Equipment of Huge Repair Works in London

New Overhauling Depot of the London Omnibus Co. that Operates Over 3,000 Omnibuses is Splendidly Equipped with Compressed Air Devices

By ROLAND H. BRIGGS

THE SUPER-GARAGE described below was opened recently in London. Although it is used solely for the repair of one type of vehicle, and of only three models of that type, which are themselves identical in many details and which are all built by one company, and although no manufacturing whatever is done, the main building of this mammoth repair establishment covers three hundred thousand square feet, and in it are employed over 2,200 men. It is the new Chiswick overhauling depot of the London General Omnibus Company, which has over 3,000 omnibuses constantly running through the most congested parts of London, and far out into the surrounding country on all sides.

The main features of this important progressive step in motor engineering are the centralizing of all the repairing required by the company in one great works, the institution of a complete system of mass production and standard organization to cover all the work of overhauling and repair, and the application of compressed air tools to a very large and varied series of operations, some of which are illustrated in the accompanying photographs.

A very small part of the huge factory in which these 3,000 omnibuses are completely overhauled every year, and in which a multitude of minor repairs are performed, is shown in the first illustration, page 218, and in the foreground may be seen the Ingersoll-Rand air compressor unit. This is a 50-h.p. electrically driven compressor. A close-up view taken while the compressor was running shows the short belt drive. Another similar compressor is to be installed later.

Behind the compressor are the offices of the works-controlling staff, which are raised above the floor level and from which a clear view of the whole vast mechanical section can be obtained, there being no partition across this section anywhere although it is 350 feet wide. In the far corner of this great workshop is the wheel and tire section.

On one side of this are the tire stores, where a very large number of the solid rubber tires used for the motor-buses are always kept in stock. On the other side, a row of acetylene welders are at work repairing the metal parts of the wheels. Between the tire stores and the acetylene welders are the benches where the wheels are taken apart and the presses in which the old tires are forced off the wheels and the new tires placed in position. It frequently takes two or three times as much power to force off an old tire as it does to force on the new one. One of the illustrations shows a man at work with a pneumatic tool on the tires in one of these presses.

A still more interesting use of compressed air in this department is shown in another illustration, where a workman is screwing up the clamping nuts on a wheel with a pneumatic spanner. The use of these machines for screwing up and unscrewing these nuts, which have to be dealt with in great numbers, has resulted in an enormous saving of time compared with hand methods. The piles of tires surrounding the hydraulic press, seen in the previously mentioned picture, give some indication of the number of wheels which are handled in this department.

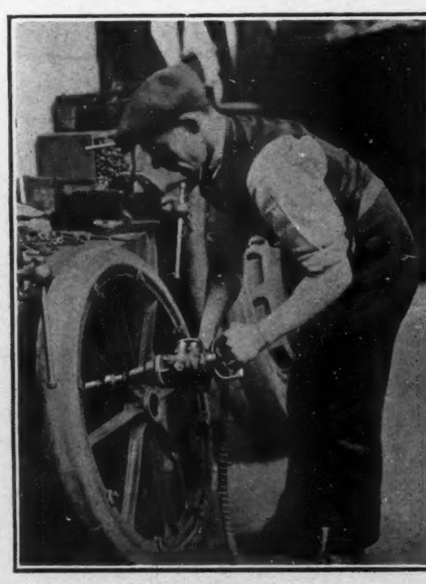
Passing on from the wheel department to the spring section, the method used for cleaning the springs was demonstrated. After being in service these springs become covered with hard baked dirt which does not easily yield to ordinary cleansing methods, but under the persuasion of the pneumatic wire brush shown in an accompanying illustration, the dirt can be cleaned off at a rapid rate and in a simple easy manner. The brush is slung on a cord from the roof beams, so that it is always in position and ready for work.

In many other mechanical sections of the factory, compressed air appliances are used for a great variety of operations. Wherever heavy or bulky material has to be handled, the ground conveyers are supplemented by overhead pneumatic hoists. Two of these can be seen in an illustration showing one of the hoists lifting one of the powerful engines which drive the motor-buses through London. Chippers are used for many operations, and in one view a fitter is shown chamfering a new side plate on the chassis frame. Pneumatic drills are also extensively used, and one of the most valuable features of these portable tools in a great repair works of this description, is that where the parts are too bulky to be easily brought to the tools, the tools can always be brought to the parts, so that hand labor is practically eliminated.

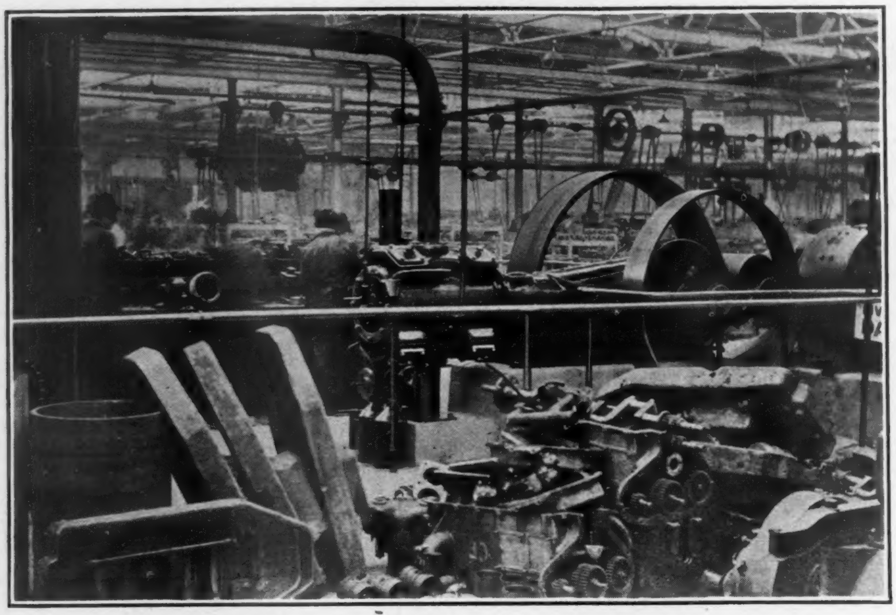
The construction of the works and the equipment which it contains are all of the most modern description. The main building is over 350 feet wide and over 850 feet long. Outside the building are testing grounds, a testing slope with a gradient of one in fourteen for trying the hill climbing and braking of the buses after overhauling; also the general offices and a large canteen and a football ground for the employees. Ingress and egress from the works are controlled by the private police office at the gates. The main building is constructed of steel frame-

Pneumatic chipper being used to chamfer a new side plate on a chassis frame.

"Little David" wire brush cleaning springs in the repair works. The hard baked dirt from the road is easily removed by this machine.



Pneumatic spanner in use at the repair works turning up the clamping nuts.



Class ER Compressor installed at the repair works of the London General Omnibus Company, Chiswick, London.

work with concrete slab walls and a roof made from corrugated asbestos. The electric supply is obtained from the Lot's Road Power Station, 1,200 h.p. being required to drive the electric motors used in the factory.

The system used in overhauling the motorbuses is complete in every detail. The buses are driven to one end of the factory and are partly dismantled, and are then backed into the factory by their own power to a hydraulic lift. Small arms are slipped in under the body of the bus, by means of which the body is lifted off the chassis, the chassis is removed and an electric truck run into its place, on to which the body is then lowered. The truck carries the body to its place in the body shop, and then returns for another load.

The work of renovating the bodies is highly specialized, each man or group of men performing only a limited amount of work on each body, and as soon as this is done passing on to the next. Some parts are always renewed, others generally are capable of repair, and all are formed to standard jigs, which ensures that they fit exactly when assembled in position. Every part of the body is dealt with by separate departments, including the woodwork, glasswork, electrical fittings, cushions, advertisements, and so on, and the work is so organized that all operations proceed rapidly in sequence, no time being lost at any point. Large timber stores, a fully equipped sawmill, coach stores, sheet metal stores, smith's shop, rug washing department, and electrical department are all directly accessible to the body shop, as is also the important paint shop, which is the next location to which the renovated body is transferred.

On the far side of the paint shop are the board and advertisement departments, cushion and apron department, chassis painting department, garage, licensing department, fire station, first aid station and doctor, and the like. Five coats of paint are placed on the bodies by hand in three days, but the chassis painting provides another use for compressed air, the chassis being painted throughout in black by the spray-painting system.

The work of chassis renovation is carried out on the same systematic lines as the work on the bodies, and as the chassis on arrival is immediately separated into its component parts, the introduction of a complete modern production system is simpler in this case, as all the parts can be conveyed to their respective departments so that the men do not have to move about the shop. As the chassis is dismantled the parts are passed to the cleaning machines and tanks, where the parts are subjected to a heavy spray of hot soda water which effectively cleanses off all dirt and grease. This method is rapid and economical, the greasy water being filtered each time and used again and again.

From the cleansing department the parts pass on to the inspection section, where they are subjected to a rigid scrutiny, badly worn or damaged material being scrapped after the parts capable of repair have been separated. In addition to the numerous pneumatic hoists previously mentioned, extensive use is made of ground conveyers of gravity, traveling chain, and similar types. On one of these conveyers the bulky external parts are carried slowly across the works past lines of benches and forges, where those which require attention are put in order as they pass. All the classes of tradesmen required for the operations on these various parts have regular working places alongside the conveyer, so that their work goes on with precise regularity.

The next cross-workshop conveyer and machine plant are devoted to the important work of overhauling the engines. This renovation does not destroy engine standardization as is so often the case, but merely creates a second standard. The various operations of grinding and machining which are necessary are made to conform to this second series of standard dimensions, into which the second series of standard parts will fit without alteration. The thorough overhauling which is carried out makes the engine to all intents and purposes a new machine. Much ingenuity has been shown by the management in reducing hand operations to mechanical work by the design and construction of special machines, which have resulted in a large saving in the cost of repair work on certain operations.

The remaining work of chassis renovation is carried out on the same general lines as the above, the work going ahead in unison so that all parts are ready for re-assembly at approximately the same time. They are subjected to rigid tests, the front springs for instance, being required to stand a test of 32 cwt. without any permanent set on a special machine, and the chassis is then re-assembled, an overhead runway with pneumatic hoists being provided for handling all the heavy parts. The assembling is done on the chassis conveyer, which can accommodate about a dozen chassis at one time, and is complete by the time the end of the conveyer is reached, and the chassis is deposited on a set of rollers on the floor.

"Little David" light chipping hammer used for trimming canvas tire packing around rims of wheels.

Heavy or bulky material being handled by air hoists.

These rollers are electrically driven, and rotate, so that the engine of the chassis starts automatically and the driver runs the chassis out of the works for its trials and final inspection or adjustment. It is then driven around to where its finished body is waiting for it and the motor bus is again ready for the road in a practically perfect condition.

The average time taken in overhauling these motor-buses is four days, and a saving of 36,000 omnibus-days per annum in repair has been achieved by the substitution of the new central works for the previous arrangements of the company. The works were recently opened but the experience already gained has proved conclusively that the arrangements and organization of this factory is a step of real progress in motor engineering.

DE-IRONING WATER WITH AIR

THE WATER from some important wells of the London water supply at Waltham Abbey and Rodney Marsh being objectionably charged with iron a plant has been installed to deal with the trouble. There are twelve Candy iron-removing filters, each 8 ft. 3 in. internal diameter and 7 ft. high. The filtering medium consists of aerating and iron-removing sand and polarites. A small quantity of compressed air will be injected into the unfiltered water for the oxidization of the iron in solution. The polarite acts as a catalytic agent, transferring the dissolved air to the iron with which it combines to form an insoluble hydrated oxide of iron. By this means it is hoped to reduce any iron which may be contained in the water to be treated to 0.01 part per 100,000. Ten of the filters, which will together be capable of treating 2,000,000 gallons of the water in 24 hours, will usually be in service together, the other two serving as spares. For working the filters, a compressor plant driven by Pelton wheels has been installed.

STOPPING SUCK-HOLE LEAKAGE IN ROCK-FILLED DAMS

ENORMOUS losses in water power are readily evident in many sections of the country during dry seasons says a writer in *Popular Mechanics*. In some cases the trouble has been traced, after many attempts to locate sources of water loss at dams, to the presence of so-called suck holes, sometimes far removed from the dam itself and the sheeting adjacent thereto.

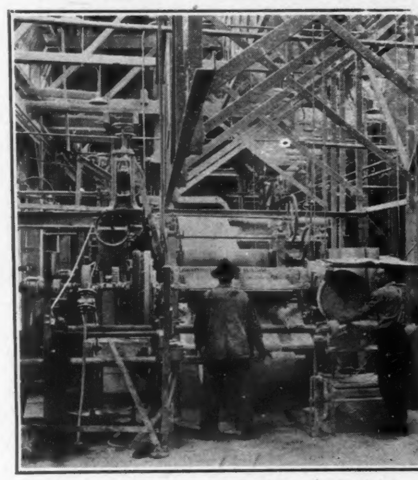
As these losses were confined principally to plants where the rock-filled type of dam was used, or dams without deep foundations, methods had to be devised not only to trace underground leaks but to remedy them. Such leaks may, in time, form a regular subterranean tunnel and drain great quantities of water.

The methods of locating these suck holes and filling them without employing costly diving apparatus are interesting. Two men in a boat, hitched to a cross-river rope, work their way back and forth from one bank to the other. For the exploration work, the boat is equipped with an electric light of about 200 watts. The lamp, incased in a waterproof marine socket, is lowered from one side of the boat until it nearly touches the river bed. The man on the other side of the boat watches, through a marine telescope, for traces of eddy currents. The process is continued until the entire area above the dam has been explored. After the leak is found, it remains to determine its shape and size. The material used for filling the hole depends on the size of the subterranean tunnel. For small channels, small field stones or small boulders are sufficient. In larger tunnels it becomes necessary to lower sacks of cinders and sometimes concrete into the orifice.

The best and most permanent method of stopping these leaks is to first let down small stones, loaded in tin cans, and, if necessary, force brush and other objects into the opening, until observation determines that the obstructions are actually lessening the flow. A few sacks of cement or cinders on top of these will finally eliminate the suction. The whole should finally be sealed over with a 2 or 3-ft. covering of concrete, spread over an area of at least twice that of the leak.

COMPRESSED AIR AIDS IN MANUFACTURE OF ROOFING

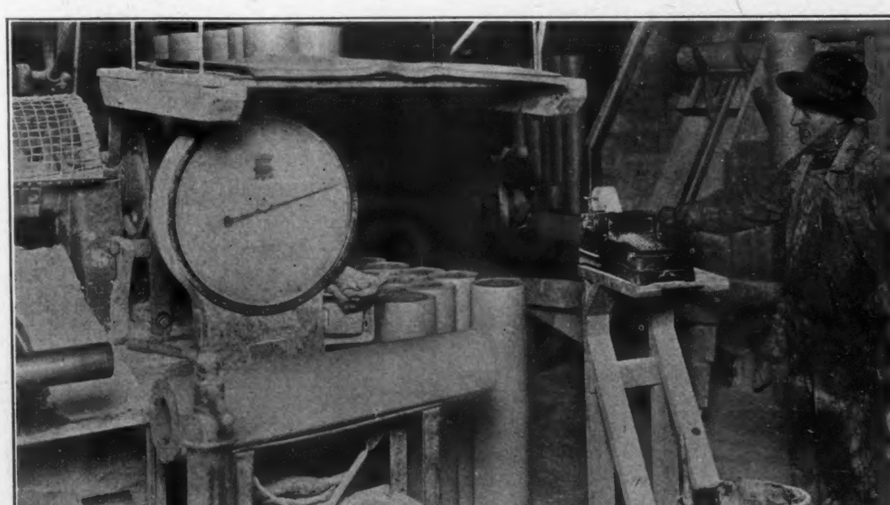
THE ACCOMPANYING photos show the novel use of compressed air at the plant of the Paraffine Companies, Inc., in the manufacture of ready roofing. There is a constant stream of roofing coming from the machine, shown in the illustration, in the form of rolls. There are two shafts on which the roofing is rolled. When the proper amount of roofing has been rolled up, the paper is cut and the second shaft is started. In the meantime, the first shaft is shot over to the right by compressed air, and the attendant at the right removes the roll, and the shaft is returned by compressed air ready for the next



Compressed air in use in the manufacture of ready roofing at plant of Paraffine Companies, Inc.

roll. When the proper amount of paper is rolled up on the second shaft, it is shot over by air pressure and the first shaft starts rolling up the roofing.

Compressed air is regularly used in cleaning the adding machine shown in one of the illustrations. The adding machine is used to determine the total number of rolls of roofing obtained from each jumbo roll, and for finding the weight of each roll and in giving the total weight of all rolls of roofing obtained from each jumbo roll. It is so dirty and dusty that it would be impossible to operate the adding machine unless it is thoroughly cleaned by compressed air at least every 30 days.



Adding machine cleaned by compressed air every 30 days.

The Republic of Latvia

This Little State Is Situated so as to Form a Natural Commercial Gateway to Northern Russia—A Russian Engineer's View of Latvia's Industrial Prospects

By N. A. TSCHERNOFF

I ARRIVED in Riga in August, 1920, with a column of refugees from Petrograd, which town I left when the Bolsheviki suddenly began to enforce their communistic policy with the utmost severity. Mobs of armed red guards overwhelmed the commercial community of Petrograd confiscating everything that in the remotest sense could be construed as coming within the definition of the term "merchandise," and the city, which up to that time had enjoyed the privilege of almost free trade, discovered that every means by which a human being could produce a livelihood had been summarily extinguished, leaving the population at a loss for providing themselves with elemental sustenance. The most melancholy impression was made upon one by the unfortunate mothers of small children, who were the first to feel the harshness of the new experiment invoking into existence "The Great Communistic Idea."

Words cannot convey a conception of the conditions prevailing when I left Petrograd, the town of my birth, possibly forever; or of my emotions when fleeing from my beloved though impoverished and suffering Mother Russia, and its people—simple children who in their naive trust in brotherly love, the spiritual heritage of a thousand years teaching of the Orthodox faith, but recently through their leaders implored the world to bring to an end the fratricidal war then raging. Truly they present to the world an unparalleled picture that is more than a mere symbol of the suffering and martyrdom of a people.

After an interminable number of registrations, cross registrations, verifications by the "Cheka" of the refugee list and other formalities, I set forth with my family in a freight car to face the new life, possibly a hard one, but at least offering the opportunity to work and the privilege of living like a human being. At last the frontier where Soviet Russia meets the newly born, independent and sovereign State of Latvia. Immediately feverish activity breaks out amongst the Letts. With round oaths they curse the country of their recent residence; their long suppressed feelings burst through the heretofore impenetrable reserve of the prudent man and they now can safely give expression to their distaste of all they have left behind; their eyes glow with renewed energy and hope—the erstwhile refugees are again reëstablished to the rank of citizenship and they are home to the land of their birth and free thought and unhampered labor. The last formalities have been complied with and we are turned over to the Lettish authorities and transfer to Lettish railway cars in which to continue our journey. At frequent intervals the ex-refugees leave the train as they reach their various destinations in their diminutive country and those remaining, including my family and myself, continue the journey towards Riga.

At last we have reached the end of our nine days' journey—Riga.

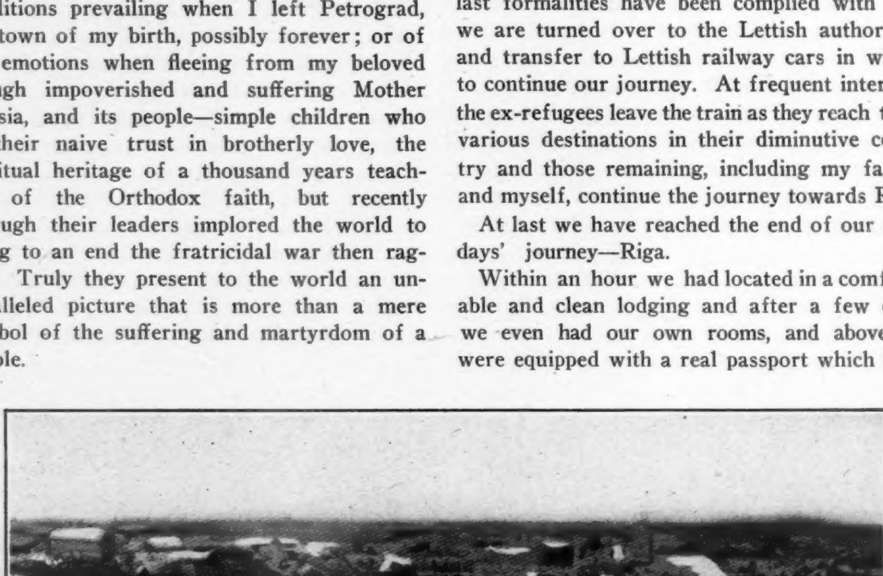
Within an hour we had located in a comfortable and clean lodging and after a few days we even had our own rooms, and above all were equipped with a real passport which proclaimed to the world that we were now citizens of free Latvia.

The external appearance of Riga underwent but little change during the period of the war; it remains the same little gem of a city, European in its outward character, and never failing to impress the Russian with its cleanliness and the orderly arrangement of its buildings, streets and hotels, offering such a striking contrast to the usual towns of Russia. However, if outwardly Riga does still maintain the same appearance, under the surface a radical change can be sensed. Formerly Riga had the ambition to appear and be as a German town, representing the leading city in the former Province now turned into the young Latvian Republic.

Now on every hand one hears the intonations of the Lettish speech and sees signs bearing Lettish inscriptions. Together with this swing away from German influence in the Riga of to-day, the significance and influence of Russian civilization are more clearly in evidence than ever before. Formerly the importance of the Russian language was decried; to-day it has become the "Lingua Franca" of the various elements sojourning in Riga. Russian civil and criminal law has been used as the basis for compiling the legal code of the new Republic, only the laws are not now enacted and enforced by the foreign agents of old who were the root and branch of the Russian "Tchinovnik" (official) system, but by their own Lettish authorities. And finally during the period of the war and the revolution, the endless drain of refugees who have drifted back and forth from time to time have brought back with them a smacking of Russian civilization, having learned to know Russia and have acquired for her a genuine affection.

Before the war and revolution, Riga occupied a position of extreme importance to the industrial life of Russia because it is directly connected by a railroad of large capacity with the open water ports of Libau and Windau. In and around the city there were located a number of engineering works, iron and steel foundries, wood-working shops and enormous shipyards fitted out with the most modern equipment and in time of peace these industries were capable of competing with corresponding German undertakings.

The rubber manufacturing plants and glass works practically monopolized the Russian market to the exclusion of similar foreign products. The city's population embraced close on to 300,000 workmen who were rated amongst the most highly skilled in all of Russia, and in fact anyone who ever mingled with the workmen of the Riga factories quickly recognizes their qualities as intelligent, first class workers whose skill and training are in nowise inferior



© Haeckel Bros., Berlin.

The market square in the town of Mitava.

to that of the best European skilled labor. In these works one found as many engineers and technical aides trained along European lines as would be encountered in large German factories of the same type.

Experienced and energetic executives managed these various enterprises and controlled a sales force made up of competent traveling salesmen, usually experts in their respective lines, who had acquired a thorough knowledge of the Russian markets and enjoyed a wide acquaintance among the trade.

In the course of recent years Riga has lost an enormous amount of factory equipment which was removed by the Russians to the interior when they were preparing to evacuate this sector during the war, and what the Russians were forced to leave behind, the Germans took. The problem now before the little Latvian Republic is to find some means of replacing these losses from the ground up if their industry is to be revived. Under the terms of the Treaty of Peace concluded a short time ago between Latvia and Soviet Russia, the Russians are obliged to return the property they had removed from Latvian factories.

The Soviet Government has commenced to fulfill this condition of the Treaty and the Latvian plants are gradually getting back a part of their equipment, but it would be idle to expect this to result in the actual restoration of their plants. The evacuation of Riga's industrial district was decided upon in the early part of 1916 and the process continued through the stormy year of 1917. Latterly the prosecution of the scheme was kept up mainly through inertia because the more portentous events of the revolution quite over-shadowed it in political and military importance. So it came that property removed from Riga would end up in totally unexpected localities and that some parts of a machine would be sent off to Samara, while the remaining parts of the same machine would end up in Rybinsk. The result of this confusion and other attendant circumstances has been the accumulation of huge junk heaps where machinery and parts have been practically destroyed and it would be indeed a gigantic undertaking to make head or tail out of the mess.

As far as it has been possible to ascertain the only notable exception to the average condition is the property of the Vseobschtschaya Kompania Elektritshestva (Russian General Electric Company) formerly of Riga. This company undertook their own evacuation to Kharkoff and managed the undertaking with such efficiency that their enormous shop inventory actually reached Kharkoff intact and the plant was assembled and started upon before the outbreak of the revolution. In respect to this property the Soviet Government has thought up several formal reasons as to why it should not be moved back from Kharkoff to Riga; at any rate they have flatly refused to do it and there is no hope for the present of seeing this plant again operating in Riga.

A general review of what has been accomplished under the restoration program clearly indicates that it is the intention of the Soviet Government to return the equipment taken from small and unimportant factories only and that, therefore, the Latvian Government will be forced to look elsewhere for the means of reviving their erstwhile prosperous industry.

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A view along Riga's water front.

The war and revolution may have effectually robbed the Latvian industry of its equipment and supplies, but the wealth of skilled labor and personnel is again available because the men have returned in very large numbers from all parts of Russia to which they had dispersed, and they have once more been able to demonstrate their great creative ability by building up in the course of a year without any visible supply of materials a sufficient productive capacity to practically meet the domestic requirements of manufactured articles.

At the present time the rejuvenated Latvian industry is living through a severe crisis, the underlying causes of which are as follows:

The Latvian Republic at the present time comprises a population of hardly more than one and a half million people and, therefore, presents a market with a very limited capacity for absorbing the output of manufactured articles, so that even the modest output of the Latvian factories was able to quickly meet the domestic demand. Of course this meant that they were confronted with an over-production both actual and potential. Furthermore when the Latvian industries got under way the currency situation was such that their money had a very low exchange value as was evidenced by the following foreign exchange rates prevalent in 1921:

1 £ Sterling equalled 1,800 Latvian rubles.
$1.00 U. S. equalled 500 Latvian rubles.
1 German Mark equalled 9 Latvian rubles.
1 French Franc equalled 40 Latvian rubles.

This meant that the daily wage of the Latvian worker who was paid from 120 to 150 Latvian rubles a day was about equal to 16 to 17 German marks a day at a time when the German worker was being paid 50 marks a day or a little more than three times as much. Naturally under these conditions Latvian goods could be produced cheaper than in surrounding foreign countries, particularly when the fact was taken into consideration that the productiveness and skill of their workers compared very favorably with that of the workers of competing countries. The natural result was successful competition with foreign merchandise in the neighboring markets of Russia, Livonia and Esthonia. This advantage rapidly disappeared when the newly appointed Latvian Minister of Finance undertook measures for raising the exchange value of their currency and with the inauguration of the new fiscal policy, the exchange value of the German mark fell rapidly. At the present time the Latvian ruble is worth about 1.15 German marks instead of the previous rate of nine Latvian rubles to one German mark.

The measures taken to raise the value of the Latvian ruble were more or less artificial, and as a rather heavy duty was levied on imports from abroad, the increased exchange value in respect to foreign currencies was not reflected in a corresponding decrease in the cost of living at home and it was necessary to maintain the old scale of wages. Under this new economic situation the Lettish worker is being paid at the equivalent rate of 110 to 140 German marks per day and his individual skill is not sufficient to offset the inferior available factory equipment.

Production costs have necessarily risen and competitive conditions are having an unfavorable influence upon the quality of the goods produced, so that as matters now stand it is not difficult to understand why a crisis should have set in. The Latvian Government is energetically combating the situation and is endeavoring to rescue their industry. Amongst

other practical measures may be mentioned a very careful revision of import duties and lowering the tariff on such articles as would assist in reducing the prices at home on supplies of primary importance and which in turn would soon be reflected in a reduced scale of wages. A part of their efforts towards industrial revival is likewise manifested in their foreign policy because the Government is endeavoring to conclude a number of commercial treaties with other countries and they have already succeeded in concluding a treaty with Soviet Russia which grants articles of Latvian origin the right of entry, duty free, into Russia. This is exceptionally important and opens the way for large industrial developments in Latvia.

These heroic measures undertaken by the Government of the little Republic have not been ineffectual and signs of a healthy economic revival are already apparent. There is already quite a little activity in the leather tanneries due to orders received from Soviet Russia. There is one direction, however, in which they have met with no success and that is in their attempts to induce foreign capital to seek investment in Latvian industry, a step which they consider so essential to the solution of their problem of aiding an economic revival. Without the effective support of foreign capital their factories will perforce continue to operate along more or less primitive lines, and be unable to greatly reduce the cost of production or to improve the quality of their output. Also they will be prevented from taking full advantage of the high ability of available labor, all of which is so necessary to more closely weld their connections to the Russian markets.

Much has been read of late and many discussions heard about the rehabilitation of Russia and a number of plans have been advanced for solving this problem. Congresses have convened, the formation of corporations of monopolistic proportion have been tentatively arranged in which various Governments are invited to participate, but so far all of these projects and attempts seem to utterly ignore any concrete plan for eliminating one of the causes of Russian disintegration by providing the suitable repair shops so absolutely essential to any real reconstruction program. All this is readily available. Certain huge shops from former times are still to be found in Latvia in a good state of preservation and admirably suited for such activities as effecting repairs to and assembling railway rolling stock, both cars and locomotives. For example, take the property of the Russian Baltic Car Works, Phoenix & Bekker and others. These works are connected with their own sidings to the broad gage (five feet) Russian Railways.

The only thing that is needed now is to install suitable equipment in these spacious buildings and they will be ready for business. So far the Latvian Government has refrained from disturbing the arrangement of the railways as they found them after the Germans retired. The old standard Russian gage of five feet is used on lines east of Riga going into Russia and the European standard gage (4 ft. 8½ in.) is used south and west of Riga towards Europe.

The Latvian railways are fortunate in that they are in full possession of their former shops and in most instances the shop equipment is fairly complete. Due to the fact that the territory served by these repair plants is now curtailed in comparison to former times, it develops that the shop capacity is many times in excess of requirements for repairing their own rolling stock. Under these circumstances the Lettish authorities are in a position to and willing under certain conditions to enter into an agreement with foreign contractors whereby the excess capacity of these railway shops would be made available for effecting part of the repairs for the Russian transportation system. Port facilities for unloading and handling supplies incidental to such a scheme are quite adequate.

I noted from a personal investigation of the factory situation in Riga that the Soviet authorities view with favor the idea of utilizing the facilities available in Riga as a part of the general rehabilitation scheme, so that it would not be difficult to secure their coöperation and active support in this connection. Incidental to what can be accomplished in Latvia towards the restoration of Russia is the opportunity to use this country as a base from which to arouse the immense industrial strength of Russia—extend the Russians' coöperation and accord them indirect financial support. Upon this very simple foundation the coming industrial leaders of Russia could rest the new commercial structure which will naturally take form under the stimulating influence of foreign financial aid, and at the same time a haven would be provided where their key industries would be sheltered from Russian political squalls, of which there will surely be many because the political barometer will point to stormy weather more than once in the course of the near future.

In recent months much discussion has cropped up concerning the importance of the future roll to be played by the new "Soviet Bourgeoisie" in the reconstruction of Russia. After having spent three years in the work of providing equipment for the ways of communication where I had the fullest opportunity to observe the character of those that constitute this so called new "Bourgeoisie" I came to quite the contrary conclusion. Their habits and mental attitude while at work are those of jackals snarling and quarreling over a corpse, and I do not see how it could be possible for them to assume the courageous leadership that will be essential to successful achievement in matters industrial.

During the existence of the Soviet Government these ubiquitous "white (or red?) hopes" have been merrily engaged in destroying what little remained of Communism in trade and industry and then gathering unto themselves the remnants. They are not competent for greater undertakings and it will be necessary to eliminate them before a real revival of business can commence. They will be supplanted by foreign capitalists and the old Russian "Bourgeoisie"; and they will not be missed.

I have already touched on the point that Riga retains its European aspect and that arriving travelers will find comfortable hotel accommodations at their disposal and their wants in respect to the provision of food can be amply catered to. Public service facilities, such as tramways, telephones and the central electric power stations are operating faultlessly and there is another advantage to be had that cannot be found in other European cities, namely, first class furnished rooms are plentiful and can be rented for the equivalent of from $3.00 to $5.00 per room per month. Those desiring more commodious accommodations will find that they can easily rent apartments.

A very attractive seaside resort is situated at a point not far from Riga, as a matter of fact, just one hour's railway journey and here one finds that rare but delightful combination of a sheltered sea, stately pine forests and a beautiful beach of clean white sand which stretches out for several versts in length. Getting about is not inconvenient because the Latvian railways have been able to re-establish regular and reliable railway service, which if anything, is better now than at any previous time, and a journey through the country need not therefore be looked forward to as a depressing experience, not even by the more or less spoiled Europeans. At the present time through train connections are provided which makes it possible to journey to or from any of the European capitals without a change of cars and these trains include in their makeup sleeping cars operated by the International Sleeping Car Company.

The Latvian Government is under the capable end energetic leadership of Premier Mayrovitz and their policies show that they are fully cognizant of the fact that the desired results in the matter of reconstruction can only be accomplished through wholehearted coöperation with foreign capital and they seem to lay particular value on attracting American business men into the country.

Right now the question of Latvian independence is one of life and death for without their independence they would surely sink into and be swallowed up by the morass of Russian ruin. Foreign powers should realize this and appreciate the urgent need of adopting a policy towards Latvia designed to preserve their independence, not overlooking the evident attitude of Russian patriots, who, far from being interested in seeing anyone bring about Latvia's downfall and subjugation by the Soviets, believe that a successful outcome of Latvia's fight for self-determination would in the long run be the safest guarantee of a national renaissance in Russia. Instead of opposing Lettish aspirations, Russians see in them a counter-balance against Russian reaction towards Imperial despotism.

The cable ship *All America* has begun the work of laying a cable between Colon and Port Limon, Costa Rica. When completed this cable will afford Costa Rica the only cable communication on the Atlantic with the outside world.

It is reported by Consul Sycks, Turin, that the hydroelectric power in Italy as of January 1, 1922, is 1,191,797 horsepower.

Holing Through the Shandaken Tunnel Between Shafts Nos. 5 and 6

Banquet Held Hundreds of Feet Below Surface to Celebrate the Completion of This Part of the Great Water Supply Project

By D. E. DUNN

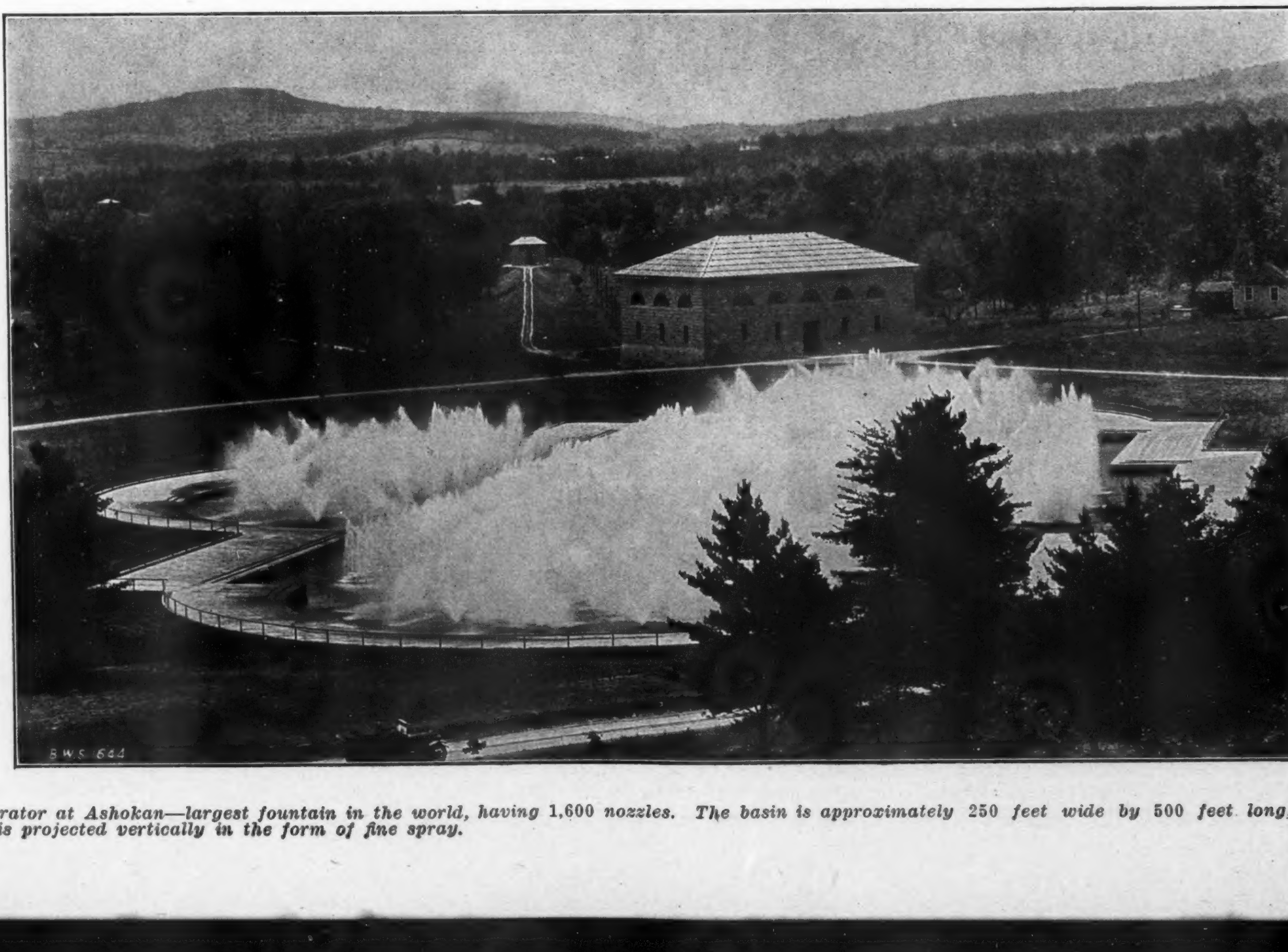
A VERY unique celebration was held in Shandaken, Ulster County, New York, on Saturday, May 20th, when at a depth of 647 feet below the earth's surface a banquet was given to celebrate "holing through" on that part of the great Shandaken Tunnel which lies between Shafts Nos. 5 and 6. One hundred and fifty men were present, including all of the executives, engineers and superintendents of the Ulen Contracting Corporation from Mr. Henry Ulen, the president, and Mr. T. S. Sheppard, general manager, on down; Mr. J. Waldo Smith, Chief Engineer of the Board of Water Supply, New York City, the commissioners and engineers of the Board, and representatives of the E. I. du Pont de Nemours, Blaw-Knox and Ingersoll-Rand companies.

The men assembled at the top of Shaft No. 6 at noon. Here they donned rubber coats and hats (slickers and southwesters) as water seeps through the ground at various points in the shafts forming a continuous downpour like a heavy rain, no matter what kind of weather there is on top. Just before going underground a group picture was taken of the entire assembly. For some psychological reason the man who wields a shovel likes to have his photo taken in a dress-suit. For this same reason perhaps, with reverse English, some of those giants of the slide-rule and chart and engineering endeavor in general, were greatly pleased to be pictured in "rough-and-readys." After the group picture the commissioners of the Board of Water Supply were photographed.

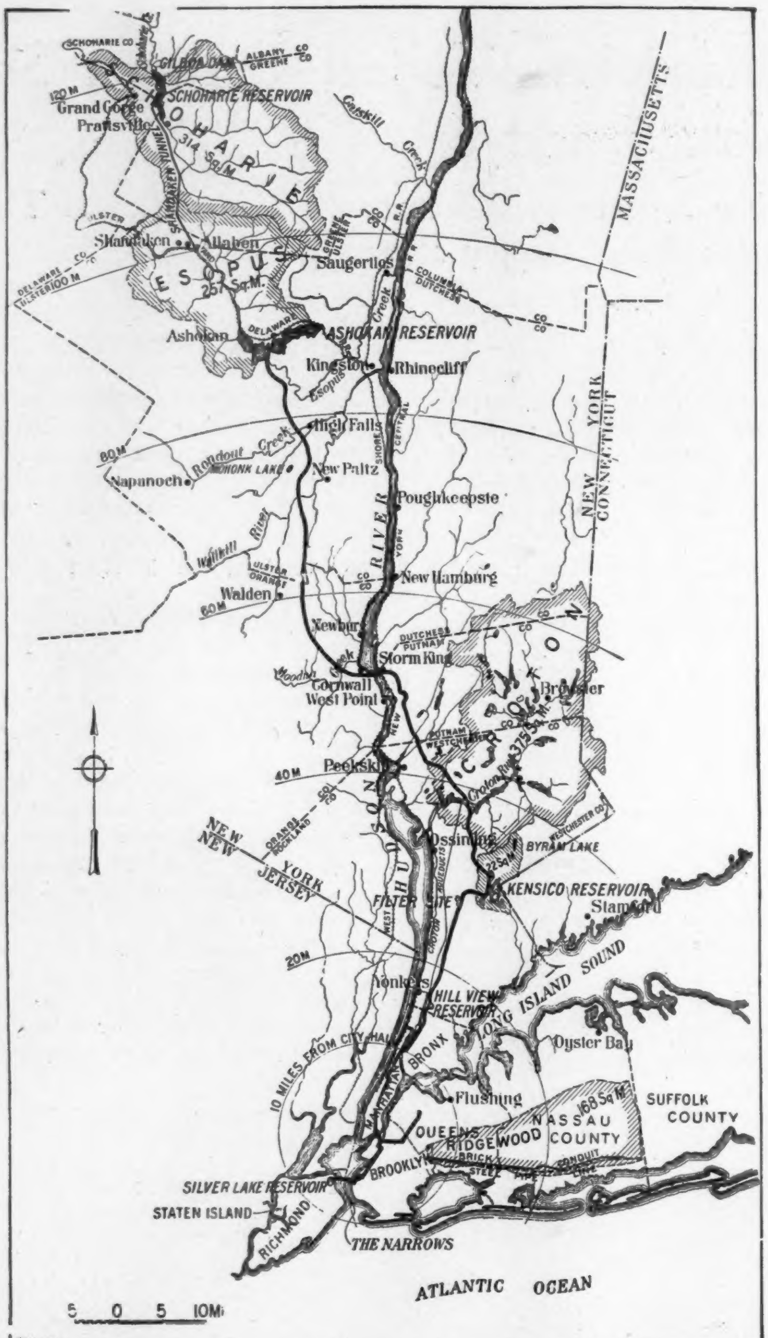
About fifteen minutes were consumed in lowering the party down to the bottom of the 647-ft. two compartment circular shaft, measuring thirteen feet in diameter. Twenty feet along the tunnel from the shaft was one of the two partitions which divided the "banquet hall" from the rest of the tunnel. The "hall" was about 175 feet long, electrically lighted and heated. For nearly the entire length there was an oil-cloth covered table flanked on each side with benches. Under foot was a new laid plank floor. The decorations consisted of banners and pennants. Lilacs and apple blossoms were on the table in addition to the "Boutonniere" of violets at each cover. There is no need to make you hungry by describing the lunch, or thirsty by telling of the "near" beer which was "not so far." The Kingston citizens' twelve-piece band enlivened the lunch. Superintendent "Bob" Parker, who is in direct charge of all work at Shaft No. 6, certainly showed that his skill as an epicure and a host is on a par with his well-known ability to drive tunnels through any kind of ground on record time, and the ground in this particular tunnel was exceedingly difficult.

Before lunch the party was transported to the break-through in about a dozen newly scoured ore cars. The point of meeting was about 6,800 feet from Shaft No. 6 and about 6,555 feet from Shaft No. 5. The excellence of the engineering and carefulness of the work were seen here for the two tunnels, each over a mile and a quarter long, met within one-quarter inch variation in grade—a truly remarkable feat. The Board of Water Supply Commissioners were photographed seated on the pile of rock made by the final blast.

When the Shandaken Tunnel is finished, Catskill water supply system as planned about a generation ago, will be completed. This is the largest water supply system that has ever been undertaken. It includes five immense reservoirs: the Ashokan reservoir, which is twelve miles long and under the surface of which lie the remains of seven villages; the Kensico



Aerator at Ashokan—largest fountain in the world, having 1,600 nozzles. The basin is approximately 250 feet wide by 500 feet long, and the water is projected vertically in the form of fine spray.



The Catskill water-supply system, showing the Schoharie and Esopus watersheds, the line of the aqueduct and their relation to the Croton and Ridgewood systems.

Storage Reservoir, near White Plains; the Hill View Equalizing Reservoir; the Silver Lake Terminal Reservoir on Staten Island, and the large Schoharie Reservoir which is now under construction. It also includes the Catskill Aqueduct which extends 92 miles from the Ashokan reservoir to the northern boundaries of New York City, and 35 miles of tunnel and pipe line extending through Manhattan Island and branching under the East River to Queens and under the Narrows to Staten Island, in addition to eighteen miles of Shandaken tunnel now nearing completion.

Catskill water has its origin in the Esopus and Schoharie watersheds. These watersheds, occupying the central and eastern portions of the Catskill mountains, collect the stream flow from the mountains of sparsely populated areas which they embrace. The Esopus watershed, draining naturally into the Hudson river, has an area of 257 square miles. The Schoharie watershed, draining to the north into the Mohawk river, has an area of 314 square miles. The combined drainage area of these two sources is therefore 571 square miles, and it is conservatively estimated that 600 million gallons of water daily can be drawn.

The Catskill aqueduct, leading from the Ashokan reservoir to the city, has a capacity of about 600 million gallons per day.

While the Esopus flows out of the Catskills through the southerly gateway toward Kingston and the Hudson river, the Schoharie leaves the mountains through the northerly portals to join the Mohawk river near Amsterdam. It lies at a sufficiently high elevation to enable the flow to be intercepted by a dam at Gilboa, reversing the direction and sending the water through an eighteen mile tunnel under the intervening Shandaken mountain range into Esopus creek at Allaben in Ulster County. The water thus diverted will join the water of the Esopus and find its way for fifteen miles into the Ashokan reservoir, where it will be available for the main Catskill aqueduct. Thus the Catskill system is extended 36 miles, making a distance of 156 miles from the Gilboa dam to the Silver Lake reservoir on Staten Island.

In order that the quality of the water delivered should be of the very best, aeration basins, which consist of a large number of small fountains, have been constructed at both the Ashokan and the Kensico reservoirs. The purpose of these fountains is to throw the water into the air and convert it into a fine spray so that the disagreeable tastes and odors which, at some seasons of the year may occur, will be eliminated.

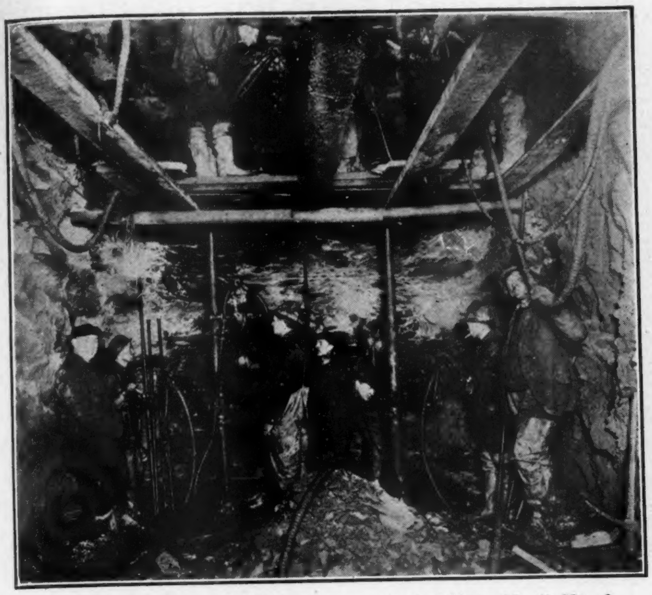
For insuring the sanitary quality of the water a chlorinating plant was installed at the Kensico reservoir and all of the water at that point is sterlized and rendered entirely pure. Work was started on construction in 1905 and the last part of the program will be finished in 1925. It has been continuously under the supervision of J. Waldo Smith, Chief Engineer, with Thaddeus Merriman as his principal assistant.

The Shandaken tunnel, which is 18.1 miles, to be exact, in length, is the longest tunnel in the world for any purpose. It is 1,586 feet longer than the city tunnel of the Catskill aqueduct, which was heretofore the longest tunnel in the world. It is horseshoe in section and concrete lined, with inside dimensions of 11 ft. 6 in. in height by 10 ft. 3 in. in width, and provides for a uniform slope of 4.4 feet per mile, except for the northerly 3½ miles, which is depressed, making that portion a pressure tunnel. The intake is located about 3½ miles north of the Village of Prattsville, from which point the tunnel extends in a generally southeasterly direction to just south of the Village of Allaben, where it discharges into the Esopus creek.

Seven intermediate shafts are provided, the aggregate depth of shafts being 3,238 linear feet, and the maximum depth of a single shaft is 630 feet. The minimum distance between shafts is 1.3 miles and the maximum 2.7 miles. All shafts are circular and lined with concrete and will be covered with shaft houses built of native stone. The upper portion of the intake shaft is so constructed that it will act as a Venturi meter and the building over this shaft will also contain the control gates and the keeper's residence.

The contract for the construction of the tunnel was awarded to the Degnon Contracting Co. on November 9, 1918, in the estimated amount of $12,138,738.00. The earlier stages of construction were affected by economic and labor conditions brought about by the World War, but in spite of these difficulties progress has been made.

A very excellent description of the Shandaken tunnel, Gilboa dam and Schoharie reservoir by Mr. R. G. Skerrett appeared in the November, 1920, issue of COMPRESSED AIR

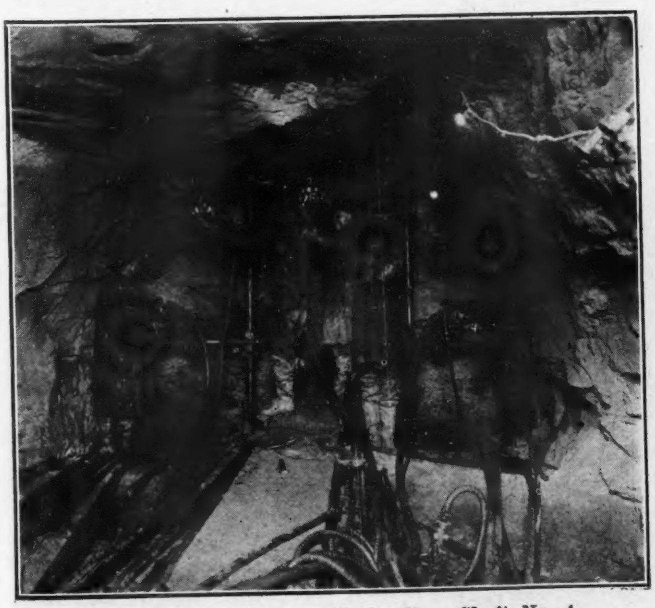


Six Leyner-Ingersoll drifters in north heading, Shaft No. 6.

A No. 56 H clay digger and "Jackhamer" tunneling in clay and shale.

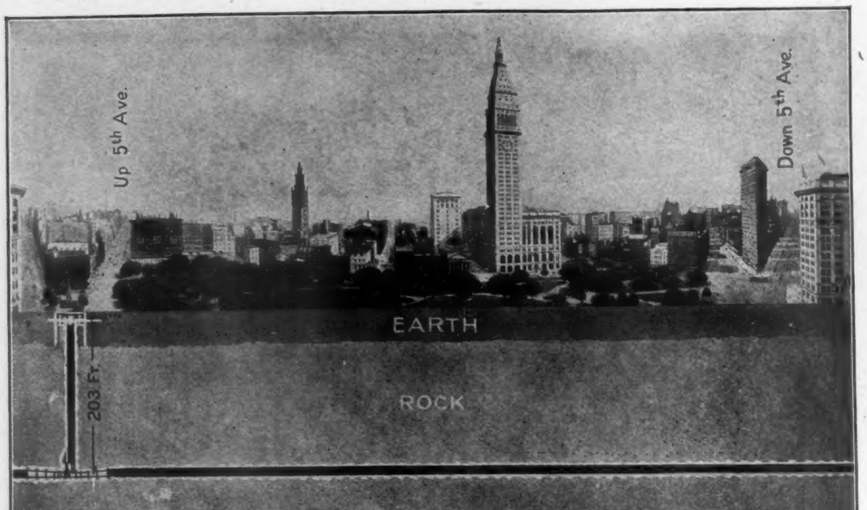
Officials of Ulen Construction Corporation and Board of Water Supply.

End view of complete section in place.



Four drifters driving north heading, Shaft No. 4.

Leyner sharpener and oil furnace used for sharpening drill steel at Shaft No. 3.



Full-circle panorama of New York City's streets around Madison Square, showing Shaft 18 and a portion of the city tunnel in the rock more than 200 feet beneath the surface. Madison Square Garden tower, the Metropolitan tower and the Flatiron building are easily recognized from left to right.

MAGAZINE. Since the publication of that article, the contract was relinquished by the Degnon Contracting Co. and assigned to the Ulen Contracting Corporation on November 11, 1920. This work will be completed a year before the time specified in the Ulen contract. The excavation will be completed about November of this year.

On April 1, 1922, all the shafts had been excavated and lined with concrete, and at six of the eight shafts, tunnel excavation was in progress and 76,000 linear feet, or 80 per cent. of the total length of the tunnel, had been excavated. The tunnel construction includes about 600,000 cubic yards of rock excavation, 100,000 cubic yards of earth excavation, 200,000 cubic yards of concrete masonry and 445,000 barrels of Portland cement.

The entire plant is operated by electricity, storage-battery motors being used to haul muck both in the tunnel and on the surface. To furnish power for the tunnel work, a high-tension transmission line was built from Saw Kill, near Kingston, where connection is made with the Central Hudson Gas and Electric Company's lines. This line is 48 miles long and was later extended six miles to supply power for the Gilboa dam, thus making 54 miles of specially constructed power-lines for the Schoharie work. At present there are about 1,500 men employed on this contract.

The maximum progress which has so far been made on the excavation of the Shandaken tunnel may be stated as follows:

Maximum monthly excavation in 12 headings	5,593 feet
Maximum weekly excavation in 12 headings	1,362 feet
Maximum monthly excavation in one heading	608 feet
Maximum weekly excavation in one heading	150 feet

The Ulen Contracting Corporation has shown exceptional ability for this work and has made extraordinary good progress. Good fellow-ship and coöperation have characterized their entire organization, which, under their excellent management has been productive of most satisfactory results.

RADIUM

Officials of the Bureau of Mines have found that the carnotite deposits in southwestern Colorado and eastern Utah are the largest bodies of radium leasing ore in the world, and to-day the United States produces much more radium than all the rest of the world together; but the actual quantity is not big enough to brag of. From the beginning of 1913 to January, 1921, approximately 115 gm. (less than 1-4 lb. Avoirdupois) of radium element was produced in this country. Probably not more than 40 gm. (less than 1-10 lb.) has been recovered from foreign ores since the discovery of radium by Madame Curie. This infant industry surely needs the help of the tariff tinkers.

AUTOMOBILE DEMAND AND PRODUCTION

Apparently one of the surest of national industries for years to come must be the production of automobiles. There is at the present time an apparent unusual demand for 2,000,000 cars. Estimating the life of an auto at from five to six years, the annual replacements amount to 1,500,000 cars, and at least 500,000 must be added to this to cover the additional requirements of new and old users. The total assumed above is well in excess of the average production of the last few years and has been exceeded only once in the history of the industry, 2,241,000 cars being the record for 1920. As recently as 1914 there were less than 600,000 built.

Mr. W. G. Hudson, vice-president of the Guarantee Construction Company, has retired. The other members of the staff elected are: C. L. Inslee, president; Edward Burns, vice-president; W. W. Ricker, treasurer; and E. A. Schweppe, secretary.

DEVICE FOR MEASURING SOIL PRESSURES

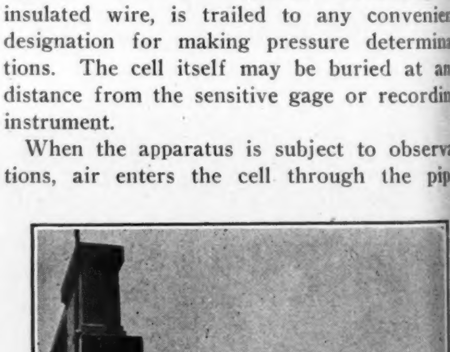
By S. R. WINTERS

DESIGNING engineers, when engaged in the building of highways, dams, bridges, or other structures, need to have knowledge of the distribution of pressures through earth fills. Apparatus for determining the force exerted by a concentrated load due to a copious supply of soil has been conspicuously absent in the past. Now, owing to the ingenuity of A. T. Goldbeck and E. B. Smith of the Bureau of Public Roads, United States Department of Agriculture, a device has been invented for measuring soil pressures. The use of compressed air makes possible the successful operation of the mechanical contrivance known as the Goldbeck soil-pressure cell.

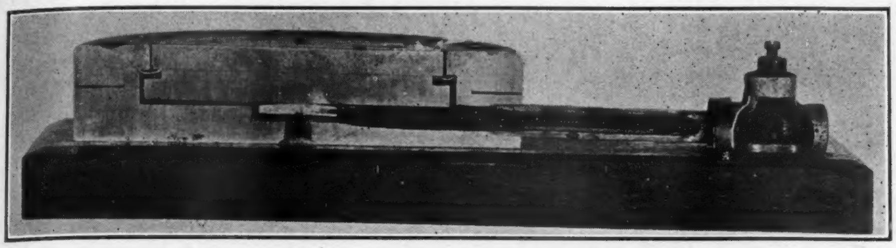
The principles governing the operation of this measuring apparatus are threefold: An equilibration—a balancing of two scales equally —of the pressure exerted by the soil with compressed air within a tiny cell buried in the earth where determinations are to be made; a detection of the equalizing forces of soil and air pressure by the breaking of electrical contact within the cell; and the measurement of the compressed air present in the narrow-confined cavity at the moment of the equalizing of forces of the soil and air pressures by means of a sensitive gage. The soil pressure cell may be barely covered in a blanket of earth as in the case of taking measurements of force exerted on a highway slab or the apparently delicate cavity lends itself to effective operation when buried 100 feet below the surface of the ground as in the case of a dam built for controlling flood waters.

In actual operation, the movable slide of the soil-pressure cell is placed in contact with the earth fill in the direction required to reveal the desired component of force being exerted—horizontal, vertical, or oblique. A pipe one-eighth of an inch in diameter, containing an insulated wire, is trailed to any convenient designation for making pressure determinations. The cell itself may be buried at any distance from the sensitive gage or recording instrument.

When the apparatus is subject to observations, air enters the cell through the pipe,



Earth pressure on retaining wall 16th Street extended at Military Road, Washington, D. C., being determined by Goldbeck soil-pressure cell.



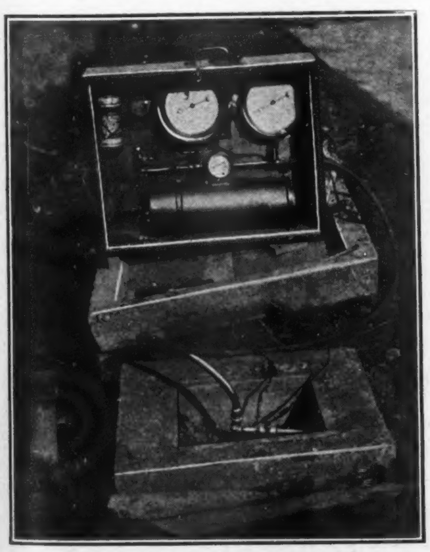
View of Goldbeck soil-pressure cell, which may be buried just beneath the surface of the ground or 100 feet or more below as may be required.

previously referred to, and when the force of the compressed atmosphere barely exceeds the pressure exerted by the soil the electrical contact is disintegrated. This critical point is instantly revealed by the extinguishing of a tiny electric light. Forthwith, the observer in charge of the indicating mechanism notes the force registered by the pressure gage.

The apparatus is portable, and when field measurements are to be made the indicating instrument can be stationed at any accessible location. The compressed air and electrical connections are so arranged that only a few seconds are required to shift from one cell to another. At the bottom of the containing box, as can be seen in one of the photographs reproduced herewith, is fixed in a stationary position a compressed-air bottle which can be pumped up by use of a hand pump.

A rough gage is affixed to the pump for recording its approximate pressure. Two accurate standard pressure test gages are stationed in the path leading to the pressure cell buried in the earth fill. These are located immediately above the compressed-air bottle, and are clearly seen in the illustration showing the indicating instrument. One of these gages is graduated from zero to 30 pounds by increments of 0.2 a pound, while the other recording unit registers up to 100 pounds in numerical increases of one pound. A dry cell, a switch, and an electric light are the only electrical units involved in the operation of the Goldbeck soil-pressure cell.

Valves are placed in the compressed air line



Close-up view of indicating apparatus of Goldbeck soil-pressure cell. Connections are made to the buried cell by means of a pipe and rubber hose. In the bottom of the box is seen the compressed air bottle. Pressure gages are seen for noting the pressure when electrical contact is broken.

adequate to the needs of the observer in controlling the forces dissipated within the soil-pressure cavity. So finely gaged is the device that it is feasible to regulate the volume of increase of pressure in the cell so that it will not exceed the force of the earth fill acting on the outside of the small enclosure by more than one-tenth of a pound to the square inch after the electrical contact is broken. When determining the force being dissipated on the device buried under an earth fill or at any point where soil pressure is desired, a rubber hose trailing from the indicating instrument is connected with the pipe leading to the buried cell and the two wires of the electrical circuit are suspended in their proper position. The valve of the compressed air bottle is then opened slightly to admit of the air flowing very slowly into the diaphragm cell.

The electric switch is put into action, thus illuminating the tiny electric bulb. The operator, standing "at attention," is ready to manipulate the exhaust valve which permits of a curtailment of the force of the air in the cell immediately. His optical attention is focused on the delicate pressure gage and the behavior of the tiny electric illumination. Once this light flickers beyond recovery, the dial of the pressure gage is faithfully observed. At the same time, the observer opens the exhaust valve as a precaution against the air pressure exceeding the force exerted by the earth acting on the buried cell. Otherwise, in the absence of the opening of this valve, future readings might be effaced, a condition attributable to a permanent deformation of the soil.

BASALT HANDLED LIKE PUTTY

Dr. Ribbe of Auverne has at last succeeded in melting basalt and returning it to a condition more adamantine than before according to an article in *Scientific American*. This makes the rock available as a building and paving material of unexcelled quality, and as an insulator that dispenses with cement. We may now have brick and tile impervious to acids and more durable than ordinary stone. America is deeply interested, for if the process does what is claimed for it we can utilize the huge quantities of basalt now lying idle.

May exports of automotive products from Canada reached the total of $1,728,302, an increase of 15.1 per cent. over the value of exports during April. The total of 2,562 passenger cars exported at a value of $1,498,276, represented an increase of 10.4 per cent. in number and 10.3 per cent. in value over April.

COMPRESSED AIR PUMPS SAND OUT OF WELL

THE SUCCESSFUL use of compressed air in freeing deep wells of sand plugs is described by Dennison Fairchild in the *Engineering News-Record*. He says:

"One well, with an eight-inch casing 145 feet deep (from which about 100,000 gallons of water was pumped daily), became clogged with sand to such an extent that it practically stopped the supply. A test developed fourteen feet of sand and small gravel. A three-fourths-inch pipe to the sand was inserted and air forced to the bottom, the rising bubbles keeping the water disturbed and the sand in suspension, and it was thrown out very quickly and at little expense. In another case the well was 236 feet deep with an eight-inch casing, and the sand was beginning to shut off the supply and get into the pump. There was available only 150 feet of one-half-inch pipe, which was connected up with a compressor. The rising air created enough suction to lift the sand and the water was clear and running free of sand at the end of 25 minutes."

HELIUM GAS

Helium, the wonder gas, which, because of its property of non-inflammability, is so eagerly sought for the operation of monster military dirigibles, exists in the atmosphere which we breathe in the proportion of one part by volume in 185,000, according to Dr. R. B. Moore, chief chemist of the United States Bureau of Mines. From samples of air taken at an altitude of several miles, the proportion of helium has proved to be about the same as at lower levels; at extremely high altitudes, such as 100 miles or more, the proportion may, however, be much increased, says Dr. Moore. Helium is also found in very minute quantities in sea and river water; undoubtedly it exists in some of the fixed stars, as well as in the sun, and its presence has been spectroscopically determined in many nebulae. Helium is found in the gases evolved from many mineral springs. Helium is found also in some volcanic gases, and in many rocks and minerals, being almost always associated with those of radioactive character. The story of helium is one of the romances of science. Probably nothing, except perhaps radium, compares with it in human interest. Helium is one of the best examples of a discovery in pure science that has wide commercial application.

Several hundred representative American business men will attend the Second General Meeting of the International Chamber of Commerce to be held in Rome during the week of March 19, 1923, according to an announcement made recently by the American Section of the Chamber. The meeting will bring together leading business men from all over the world for a discussion of world trade problems. Sixteen countries affiliated with the International Chamber will send delegates, while several other countries which have made application for admission to membership in the Chamber will be represented.

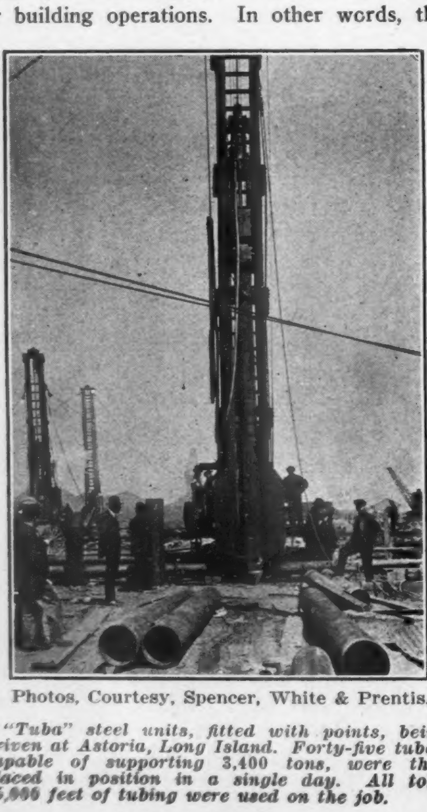
Sinking Foundations to Rock by Means of a New Method

By JOSEPH SALATHIEL

THE MODERN business building in America tends more and more to mount skyward than to increase its ground area for the very good and sufficient reason that land value makes expansiveness extremely costly, especially in populous cities. As a consequence, with every added story the burden upon the foundation grows proportionately and the load is intensified upon each horizontal square foot of the sustaining substructure. In the name of security, therefore, the architect insists, wherever practicable, that the foundations be made rock-bearing.

By thus carrying a skyscraper upward, so to speak, from nature's primordial ledge, all fear of harmful settlement in the course of time is stilled, and the owner knows that the integrity of his building depends otherwise upon the character and the quality of the materials worked into the edifice—factors entirely under human control and susceptible of test and inspection in advance of employment.

In order to meet this demand for foundational rigidity and permanence of footing, it has been the practice in numerous American cities to get down to the rock, underlying a considerable overburden and, perhaps, water, by recourse either to open or to pneumatic caissons; and positive and satisfactory as are the results realized in this way, nevertheless caisson sinking, in itself, is unavoidably expensive, while conditions affecting neighboring property may add greatly to the outlays involved. Again, a rock-bearing foundation assures stability and neutralizes the possible reactions, in the future, of nearby excavations or building operations. In other words, the structure reaching down to the ledge stands firmly, so to speak, upon its own feet.



Photos, Courtesy, Spencer, White & Prentis.

"Tuba" steel units, fitted with points, being driven at Astoria, Long Island. Forty-five tubes, capable of supporting 3,400 tons, were thus placed in position in a single day. All told, 25,000 feet of tubing were used on the job.

As a matter of fact, rock-bearing foundations would be universal if it were not for the money involved in getting deep into the earth for the desired lodgement. There are parts of lower Manhattan, in Greater New York, where it is well-nigh impossible to sink caissons for concrete piers, etc., except by recourse to pneumatic methods; and it is no unusual thing to prosecute these jobs to depths of half a hundred feet and more below street level. Not infrequently an expenditure of three quarters of a million dollars is needed for that portion of a twenty-story building which lies beneath the ground; and in the creation of these substructures there is commonly required anywhere from six months to a year.

To deal with the physical circumstances imposed by nature and to achieve at the same time marked economies, engineering cunning, after wide experience, has evolved what is known as "Tuba" steel foundations. These are capable of sustaining buildings of from two to 25 floors high, and have been used where the rock lies from ten to 80 feet under soil of variable character.

Broadly stated, the new process consists of tubular steel shells which are driven into place preferably by means of compressed-air hammers. The units are generally from 12¾ in. to sixteen inches in diameter and are from ⅜ in. to ½ in. in thickness. They are made up of standard sections of seamless tubing; and the lengths of these as well as the diameters and thicknesses differ agreeably to the load to be borne and, in a measure, to the kind of earth through which they have to penetrate in order to reach the ledge. Cast-steel couplings have been devised which provide rigid connections wherever the penetration requires the use of more than a single length of tubing.

Inasmuch as there is no displacement of material as the tubing is forced into the ground, the shell can ordinarily be driven to rock without excavating the enclosed soil. When the tubing has come in contact with the rock then the shell is excavated by means of a jet of compressed air. With this done it is tested with the air hammer to make certain that the shell has a firm bearing. The next step is to fill the tube with concrete, and in this way is formed a concrete-steel column which rests securely upon the deep-lying ledge. The "Tuba" steel piles, for such in fact they are, are set in groups, and each cluster of them is bound together at the top with a reinforced concrete cap as is the practice with ordinary piles—the caps, however, being much smaller. A group of four 15-in. cylinders, for example, requires a cap but four feet square; and this aggregation is capable of supporting a dead weight of 400 tons.

The loads permitted by the Bureau of Buildings of New York City, as set forth in the code, are based upon a stress of 7,500 pounds per square inch on the steel shell and 500 pounds per square inch on the concrete. For a 15-in. tube, ⅜-inch thick, a loading of about 94 tons would be allowed. A 12-in. tube of the same thickness would carry substantially 74 tons, according to the code. However, tests made on numerous occasions, for the information of architects and engineers, have disclosed that the tubes could sustain safely double the permissible weights.

This novel type of rock-bearing foundation has been used successfully under the following conditions:

1. To rock, 40 feet below curb, to save cost as against concrete piers and to eliminate underpinning of adjoining buildings.

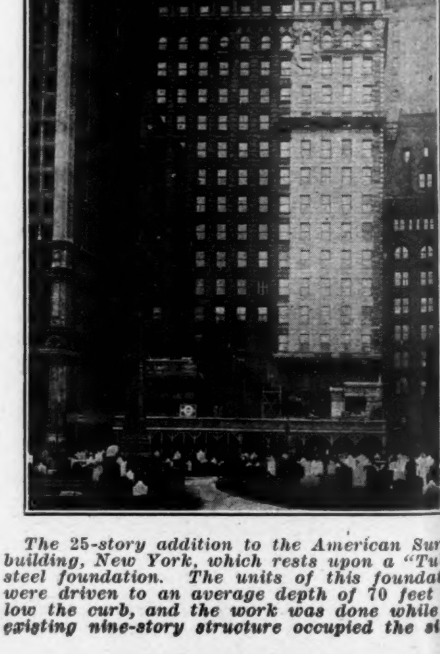
2. To rock, 30 feet below curb, to provide additional support for building already on wooden piles. Work was done inside the building where the driving of wooden piles would have been impracticable.

3. Through twenty feet of soft rock to hard rock.

4. To rock, 25 feet below curb, to avoid danger of excavating for concrete piers close to important street.

5. To hardpan, at 35 feet below curb, to save time in construction of a building whose foundations, partly installed, were halted by an unexpected drop on one side in the hardpan level.

The foregoing brings out the adaptability of the system and emphasizes the particular advantages of the air hammer which can deliver



The 25-story addition to the American Surety building, New York, which rests upon a "Tuba" steel foundation. The units of this foundation were driven to an average depth of 70 feet below the curb, and the work was done while an existing nine-story structure occupied the site.

Driving "Tuba" steel cylinders to rock 40 feet below the street level. The pier which has just been driven, and is about to be blown with compressed air preliminary to filling with concrete, is composed of four 15-inch tubes seven-sixteenths of an inch thick. The column load placed upon them is 400 tons.

a sufficient blow, with very moderate head room, to effect penetration through either earth or soft rock. Again, compressed air, as a handy excavational medium, serves well to quickly clear the tubing preparatory to filling the shells with concrete.

It is claimed, and seemingly with good reason, that "Tuba" steel piers are the equivalent of concrete piers carried down to rock, and they can be put in place at a saving in time of more than 50 per cent, with a proportionate economy in cost. The practice is growing, where the rock level varies greatly in the same lot, to have one pier on steel tubes while another, only fifteen feet away, is on a concrete column—the shells being employed for the deeper work. Because the "Tuba" steel cylinders are driven without displacement of material, and substantially without vibration, they can be got into position close to adjoining structures without occasioning damage to the latter. This obviates the need of underpinning beneath contiguous property.

Owing to the means used, cylinders of this kind can in most cases be driven concentrically under wall columns. As a consequence, this brings about economies through the avoidance of recourse to cantilever beams, grillages, and deep excavating which are required for ordinary piles, and which, besides, often necessitate expensive underpinning of near-by buildings. As is well known, there are two prime factors which often cause the cost of concrete piers to exceed the estimates—i. e., increased depth and the striking of strata of running sand. Steel tubes can be driven to added depth at a unit cost no greater than that of the original length. On the other hand, in the case of concrete piers, an addition of only five feet may, in itself, entail an outlay greater than all the rest of the pier. From the very nature of things it should be plain that the steel cylinders are unaffected by soft or water-bearing strata, save that they may be driven with more ease through materials of this sort.

GROWTH OF AIRPLANE SERVICE

THE FIGURES of the Transportation Division of the Department of Commerce practically compel all the world to take notice of the rapid development of the airplane carrying business in Europe. In the past year 842,937 kilograms (1,854,461 lb.) of mail, 24,874,505 kilograms (54,723,901 lb.) of freight and 489 passengers were carried by the Amsterdam-London aerial navigation line. On the Amsterdam-Brussels-Paris line the traffic amounted to 761,646 lb. of mail, 24,511,124 lb. of freight and 931 passengers. On the Rotterdam-Hamburg service 784-399 lb. of mail, 5,538,786 lb. of goods and 254 passengers were carried. A new set of passenger and freight rates, representing an appreciable reduction from those of 1920 and 1921 has been put into effect. Passenger rates have been reduced one-half from those of 1920. The figures not only show that there is a present or prospective profit in the business but they also surely promise a great increase of patronage.

VENTUBE

This is the name of a new fabric for ventilation tubing in mines. A test of this material was had in a large copper mine at Butte, on the 1,600 level and about 1,000 ft. from the shaft. The temperature there was 112 F., the air absolutely still and the drip of acid-water excessive, ideal conditions for fungus growth and chemical corrosion. After seven months, as reported by E. I. Du Pont de Nemours & Co., the sample of Ventube was removed and found to be in as good and serviceable condition as when first installed.

EXTENSIVE ADDITIONS TO PORT OF FRANCE

WITH THE conviction that still further freight, passengers, and therefore trade would accrue to France if the country's western ports were better equipped for the reception of the largest Atlantic liners, the port authorities at Bordeaux and Saint Nazaire are planning extensive installation improvements.

With the approval of the Midi and Orleans railway companies, which are interested, a bill will shortly be introduced in the Chamber of Deputies to authorize the construction of an outer port, to be called the Port de Verdon, at Bordeaux. The Saint Nazaire authorities have decided to deepen the harbor throughout, building in the lower roadstead a 500 metres wharf where vessels of 39 feet draft may berth.

Both these improvements will be facilitated in their construction by a liberal use of compressed air and compressed air machinery and, after completion, compressed air installations will be available, in accordance with the best modern usage, for various purposes, such as discharging of grain cargoes, etc.

The mole at Port de Verdon is to be 300 metres long and capable of taking three or four liners at a time.

JOHN A. BENSEL

John A. Bensel, for many years a prominent figure in the public affairs of the City and State of New York, state engineer for two elective terms and a past president of the American Society of Civil Engineers, died at his home, Bernardsville, N. J., recently in his fifty-ninth year.

Born in New York City, he was graduated from Stevens Institute of Technology in 1884, his engineering career commencing at once, first with the Croton Aqueduct Commission and a year later with the Pennsylvania Railroad, advancing in four years to the rank of assistant supervisor of the New York Division. This position he resigned to become assistant engineer in the New York Department of Docks and active in charge of construction. In 1898 he became chief engineer of the Department of Docks and Ferries and under his direction the Chelsea docks and extensive works on the Brooklyn water front were constructed. After seven years in this responsible service he was dock commissioner for two years. In 1908 he was appointed president of the New York Board of Water Supply then beginning the construction of the Catskill aqueduct. In his four years as state engineer he had charge of the New York State Barge Canal work.

Subsequently he was engaged in private practice in New York where his activities were too numerous and various to be enumerated. He was a member of the board of consulting engineers on the Hudson River vehicular tunnel and during the war he was a Major of Engineers, commanding the 125th Battalion with duties involving cantonment construction.

Handling Bulk Materials of Various Kinds by Compressed Air and Rotary Tank Cars

By RUDOLPH WELCKER

THE CAR-BODY, outlined in the following pages constitutes a radical departure from the customary means of transporting solid materials which have prevailed since the earliest days of railroading, and which have persisted in their original form, regardless of the great progress in the mechanical arts.

The rotary car-body as shown here is designed for the transportation of granular or pulverized materials, such as grain, cereals, cement, and fertilizer, and is also adaptable for the transportation of liquids as well as coal and ballast.

The principal feature consists in utilizing the cars in conjunction with pneumatic means for the purpose of the loading and the distribution of the contents at the terminals, thereby dispensing with the necessity of either hand labor or especially designed costly terminal-plant for the handling of these materials.

These far-reaching results have been attained by the simple expedient of making the car-body capable of being rotated on the bolsters and by providing it with loading openings, which may be hermetically sealed, after which the cargo may be discharged and distributed by means of a current of air under pressure.

Before going into the detailed description of the subject-matter I propose, for those of our readers who are not familiar with the development of more recent ideas for the improvement of the economic status of our transportation system, to give a brief outline of such measures as have received public support and which are at the present time in more or less advanced state of preparation.

It is my object in doing so to indicate how and why this special equipment may find a place in the comprehensive overhauling of our whole system of transportation in order to fit it to the task of the efficient competition of the various trade-routes.

It should be borne in mind, first, that trade routes in general represent merely the lines of least resistance, from the base of supplies to the centers of consumption and that as far as the consumer is concerned, the cost of transportation means a dead loss.

Furthermore if for economic or political reasons, the friction along a certain trade-route increases, the increased resistance will first impede and thereafter stop the flow of trade for the benefit of some parallel route, which is not similarly affected.

Considerable economy in the utilization of plant is involved in the plans of the various port-authorities, but the third and most important factor in the total expenditures, the cost of labor, is affected by political considerations and can only be effectively curtailed by the use of improved equipment.

It is felt that only a radical change in the methods of handling merchandise in bulk shipment can do away with the excessive cost of trans-shipping such materials at our terminals and though the general scheme will be subject to future development, the main outline is presented in the following.

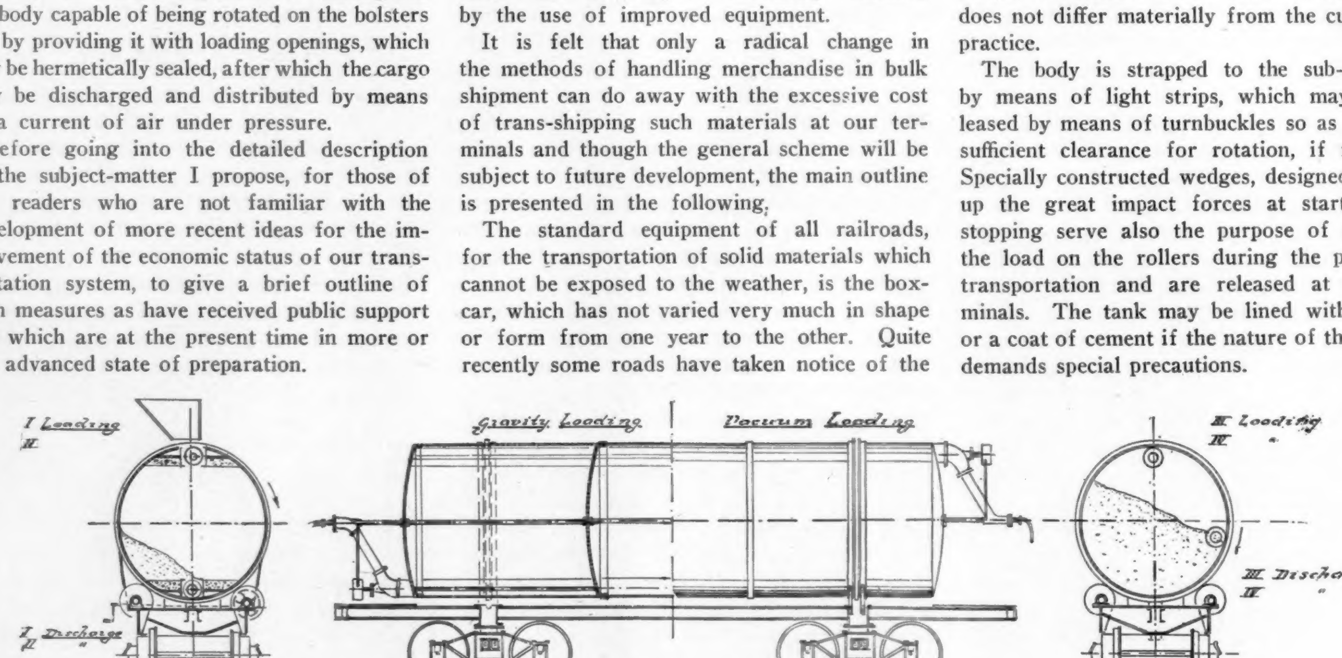
The standard equipment of all railroads, for the transportation of solid materials which cannot be exposed to the weather, is the box-car, which has not varied very much in shape or form from one year to the other. Quite recently some roads have taken notice of the fact that the nature of the freight is deserving of consideration, and experimentation began with the so-called unit-system, especially useful in conjunction with truck-service at the terminals. The implied recognition that freight should be differentiated, as to the manner of transportation and trans-shipment, has concentrated the attention on a very large and important class of freight, which may be handled by means of a carrier of the following description, called the rotary tank-car.

Design of the Rotary Tank Car

Since the body of the carrier, in its function as an unloading means, will be subjected to internal pressure, the economy of design requires a circular cross section, and the car resembles, in general appearance, the ordinary tank-car with boilerhead sides.

The tank itself is mounted on four pairs of rollers, which rest on special bolsters and has a series of loading openings extending practically over the full length of the car-body. The bolsters are supported in the usual manner, by means of standard trucks and the underframe does not differ materially from the customary practice.

The body is strapped to the sub-structure by means of light strips, which may be released by means of turnbuckles so as to allow sufficient clearance for rotation, if required. Specially constructed wedges, designed to take up the great impact forces at starting and stopping serve also the purpose of relieving the load on the rollers during the period of transportation and are released at the terminals. The tank may be lined with enamel or a coat of cement if the nature of the freight demands special precautions.



Rotary tank car with pneumatic and gravity feed and discharge.

The operation of these cars is based upon the physical properties of the pulverized or granulated materials to acquire the characteristics of fluids, when mixed in the proper manner with air under pressure. If these materials are fed in the proper manner into a current of air, it becomes possible to convey such through pipes over a considerable distance, a proceeding which has already been used practically for a number of years in a great many industrial plants. Therefore, the method itself requires no general description.

In order to adapt this well-known method of conveyance to railroad practice, it involved the redesign of the standard equipment, but with the car-body so modified, it is possible not only to deliver the contents at a considerable distance from the track, but it is also feasible to load the same car by connecting it with an exhauster and drawing these materials into a partial vacuum within the tank. If desired the rotary body may be removed from the trucks and the contents distributed through a suitable pipe-system.

By the use of the rotary type of car, it becomes possible to handle all the materials of this peculiar nature at the terminals by mechanical means only, without requiring a costly plant for that purpose.

The body is so designed that it may be used in the ordinary way for transportation purposes only, with the additional advantage of loading and discharging the contents by gravity.

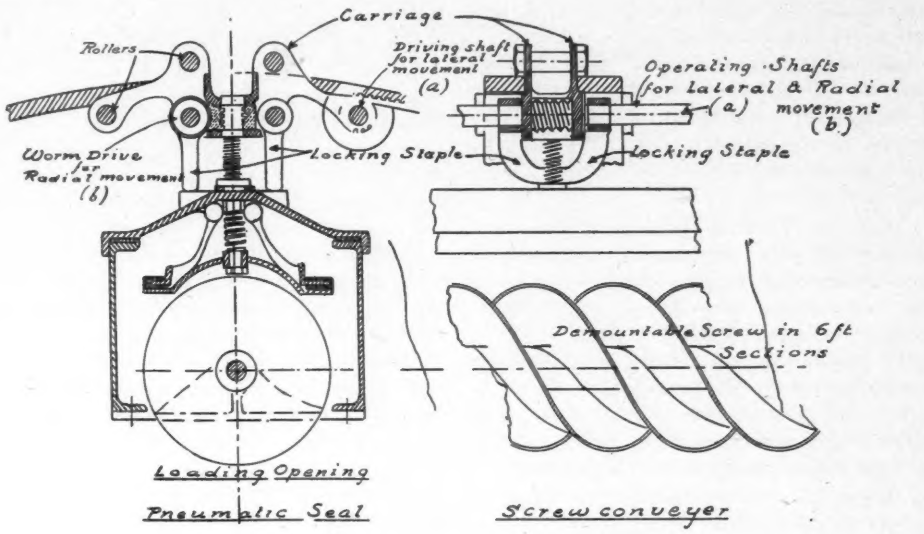
We will now examine these various ways of operation in detail and distinguish the four following methods:

	LOADING	DISCHARGE
1.	Gravity	Gravity
2.	Gravity	Compressed air
3.	Vacuum	Compressed air
4.	Vacuum	Gravity

In all these operations the rotation of the tank may be effected, either by hand lever, actuating planetary gearing connected directly to the rollers or by means of ratchet levers, which receive a reciprocating motion from pistons driven by compressed air available for the service-brakes.

Detail of Methods of Loading and Discharge

1. LOADING BY GRAVITY—DISCHARGE BY GRAVITY.—The car is loaded directly from the storage bins, overhead, through the series of openings, parallel with the axis of rotation. These



Operating Devices.

openings are then closed by manipulation of handwheels rotating shafts (a) and (b) and located at one end of each car. After transportation to the receiving terminal, the door is opened again and the car slowly discharged by rotation of the carbody on the rollers. The effect is similar to the unloading of the ordinary bottom-dumpcar, with this distinction, that the discharge remains always controllable by the operator, who can speed up or retard the movement of rotation as desired.

This feature may be of interest, if it is desired to distribute the contents along the line of travel, for instance, for the delivery and distribution of road material from trucks, or the spreading of ballast in railroad work.

If coal is to be handled in this way, it is obvious that there is not a great chance of the mass becoming unmanageable on account of freezing, and if the case should occur it becomes a simple matter to introduce steam into the sealed car.

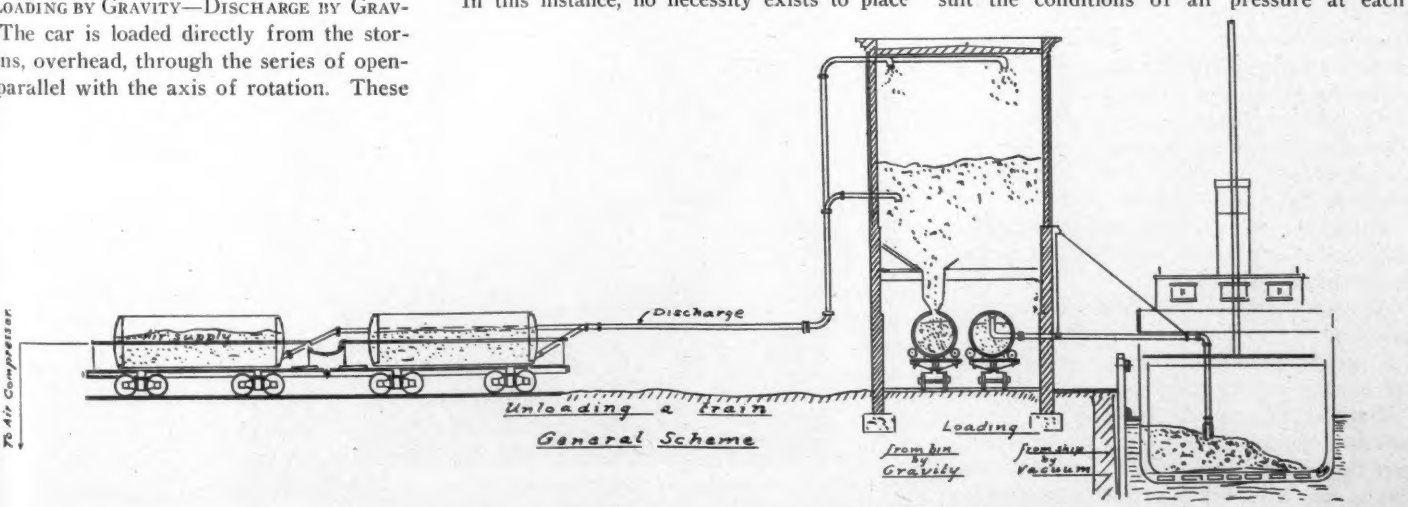
2. LOADING BY GRAVITY—DISCHARGE BY COMPRESSED AIR.—The loading proceeds in the same manner as is indicated in (1). The opening is sealed and the car transported to the unloading terminal.

In this instance, no necessity exists to place this particular car near or adjacent to one unloading device or on one particular unloading track. A few pipe lines with suitable branches will allow of connection being made, with the receiving bins wheresoever located and ships may be loaded directly, without being confined to any particular berth.

For the discharge of the contents of the car, the door remains sealed and the car is rotated slowly, after admitting compressed air through the central supply-pipe.

During the rotation the material will gravitate towards the door, but is intercepted by a conveyer, rotated by a small demountable air-motor. The material will be fed slowly into a current of compressed air, which is supplied from the central air supply pipe and carried through the terminal pipe-system to its destination. By shunting out the empty cars, it becomes an easy matter to discharge a whole trainload.

It should be observed that by synchronizing the rotation of the car-body and the conveyer screw, it is possible to secure a constant flow of material into the air current, which will be automatically regulated as to quantity to suit the conditions of air pressure at each



Plant layouts showing the flexibility of the distribution system.

moment and the nature and distance of the material to be conveyed in general.

Attention is also call to the fact that the conveyer will be always working on the top of the mass of material with the resultant advantage, that neither the packing of the materials nor its weight will cause excessive friction in its bearings.

3. Vacuum Loading—Discharge by Compressed Air.—The occasion of loading these cars by means of vacuum may arise when a train load has to be taken directly from ship or storage pile, situated some distance from the track. In this case, one side of the car will be connected to an exhauster, through a dust collector, while the other pipe-connection ends in a suction nozzle of customary design. As to the discharge, this proceeds as described in (2).

4. Vacuum Loading—Gravity Discharge.—This is simply a combination of two operations already described.

It is evident that these four methods of operations practically comprehend all possible conditions of loading and discharge which may be encountered at the various terminals and the flexibility of this equipment allows of meeting these varied conditions.

Consumption of Power.—The latest improved equipment for handling grain and the like has reduced the consumption of power to one-half horsepower per ton per hour, amounting to about 15 K.W. for a 40-ton car.

It is expected however, that this amount may be considerably reduced, because the above figure includes losses in tumbling airtraps, which are not needed with this equipment.

Construction.—These cars can be made up of light tank-steel and standard boilerheads.

The material is used economically and no special reinforcement is required.

The cars can be easily handled in train formation and the central air-supply pipes connected by standard brake couplings.

Economy in Transportation.—The elimination of bags and barrels is possible and advisable in cases like bulk cement, which is difficult to handle with the present type of box-car. Furthermore, where at present considerable losses are incurred by theft, leakage or dispersion, such losses will be entirely eliminated by the use of these rotary cars, because the car is and remains hermetically sealed in transit and can only be discharged by rotation, operating means for which are special and in possession of the crew of the train.

Economy in Loading and Distribution.—The total elimination of hand labor is a factor which will appeal to those who have to deal with labor on the waterfront.

Instead of expensive terminal equipment, simple pipe lines will be used, which are readily extended.

A number of cars may be unloaded simultaneously.

A greater number of tracks may be utilized for loading or unloading purposes.

There is absolute prevention of loss by fire, moisture, theft or dispersion, by direct conveyance through the pipes, from car to ship, from ship to car, from bin to car, without exposing the materials to the weather.

STANDARDIZATION OF METHODS IMPROVES CONCRETE PIPE

Because, in many localities, concrete pipe, when properly made, cured, and laid, is more economical and durable than other forms, investigations have been made to determine the best methods of manufacture, says *Popular Mechanics*. One result of this investigation has been the development of a device for testing individual lengths of pipe without the use of bulkheads, joints, and connecting rods. The tester consists of an aluminum cylinder supplied with rubber tubes near the ends for making a tight joint. The tester is inserted in the pipe, and water pressure in the tubes seals the joints, and is then increased until the pipe is broken. Other tests are also made and have resulted in the standardization of manufacturing methods, thereby producing a concrete pipe of materially better qualities.

VACUUM CLEANER SAVES A DAY

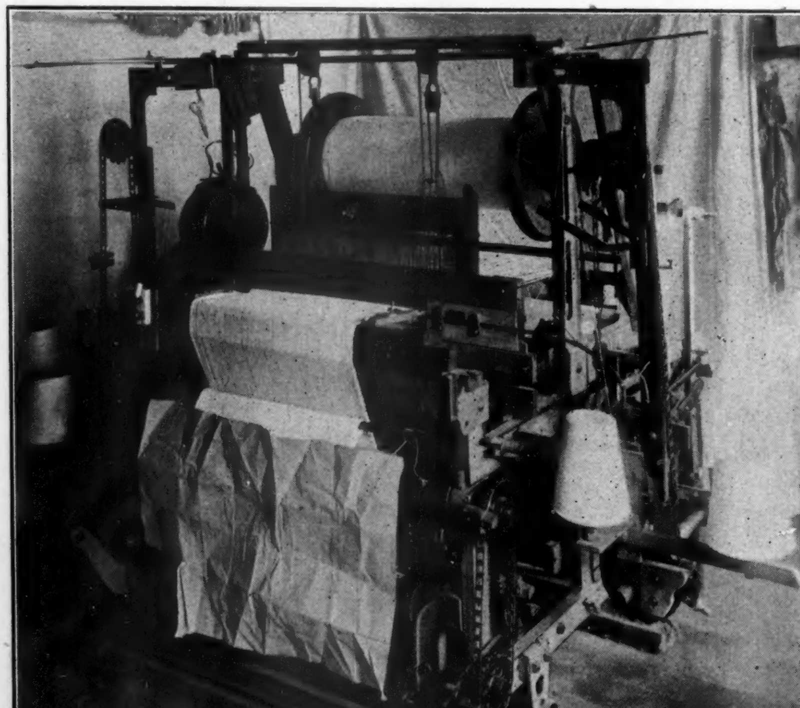
In a linen thread plant at Paterson, N. J., the lint and dust accumulations were so heavy that floors, machines and everything became coated to a great depth in the course of a few days operation and only five production days per week were possible, the entire force being put on the job of cleaning house every Saturday. A competent vacuum system was installed and Saturday has been reclaimed for production, depreciation of machines has been reduced, a serious fire hazard has been eliminated and more satisfactory conditions have been obtained all around.

SHUTTLE REPLACED BY COMPRESSED AIR

IN THE accompanying illustration is shown a novel loom on which the shuttle and picking motion are replaced by compressed air says a writer in a recent issue of the *Textile World*. The device has been developed by John C. Brooks, of Paterson, N. J. Mr. Brooks has been working on this device for several years, having taken his first patent out in 1914 and having subsequently patented improvements at various times.

In place of the shuttle boxes, nozzles or tubes are placed on the loom and connected with an air supply which, in the case of the looms thus far developed, consists of a small pump, but which on large scale use would be a compressed air line. A filling inlet is made on the top of the tube three or four inches from the end. A filling measuring device is arranged which, in the case of looms now operated consists of a sprocket chain. On the sprocket chain are two filling engagers or filling pullers.

In operation the filling passes through suitable guides, so that the filling pullers can engage it and draw off enough yarn to make a pick, in this case a double pick. When the filling puller has drawn off sufficient length of yarn, cams on the sprocket wheel engage the filling puller and tip it so as to allow the filling to escape from the puller. The yarn is then blown through the warp shed. Thus far Mr. Brooks has been using his loom for cotton toweling and house cloths, but he intends later to work on tie goods and then on fancy shirtings. He can run the loom as fast as 200 picks per minute.



Courtesy, Textile World.

Shuttle replaced by compressed air.

Clean Tubes Essential to Boiler Efficiency

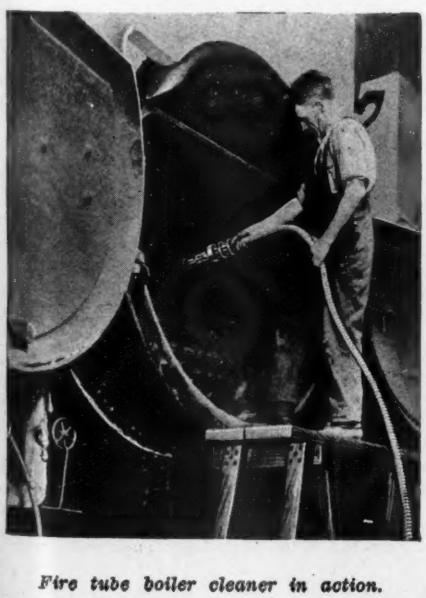
Advantages of Compressed Air for this Service Make it the Best and Safest Medium—Frequent Cleaning Means Considerable Saving in Cost of Operation

By SIDNEY MORNINGTON

ECONOMY IN fact, not a theoretical abstraction, is the something vitally essential to our industrial well being. Day by day conditions emphasize the urgent need of cutting out waste and lost motion so that our productive machinery can move along smoothly and with the greatest returns for the energy expended. Reduced to plain terms, we must get more out of the coal pile or every barrel of liquid fuel burned in the boilers of our power plants. Much, very much, can be done to improve efficiencies and to achieve savings in this basic department of our industrial life.

The average person is unaware of the extent to which America relies upon mechanical energy to fabricate its varied and its enormous quantities of commodities. Our creative wage earners have behind them individually a larger measure of horse-power than their foreign competitors in the same fields of endeavor; and the maximum volume of this helpful, labor-saving motive force is generated primarily by steam. Twenty-two years ago our manufactories and isolated plants had a combined installation of 10,600,000 horse-power, and these activities to-day have at their command 25,250,000 horse-power which calls for the yearly consumption of substantially 88,000,000 tons of coal. Under average working conditions these establishments burn their fuel with a rated efficiency of less than six per cent! Consider then, what must be the losses when the boilers are so circumstanced that they cannot meet even this standard of utilization of the B.T.U.'s in the fuel fed them!

One of the most persistent and heavy drags upon boiler efficiency is scale either enveloping or lining the boiler tubes. The thickness of this incrustation is dependent upon the character and the chemical composition of the water used and the time lapsing between cleanings. Again, the functioning of the tubes may be considerably hampered by deposits of soot or flue dust, which, like scale, check the normal passage of the heat through the metal walls to the surrounding or contained water—agreeably to the type of boiler in question.



Fire tube boiler cleaner in action.

Scales are of various sorts, and some of them, because of their porous nature, constitute a lesser barrier between the hot metal and the water than other films which more seriously interfere with heat transference. Here are the tabulated results of exhaustive tests conducted at the University of Illinois.

INFLUENCE OF SCALE ON HEAT TRANSMISSION

No.	Thickness of Scale Inches	Character of Scale	Decrease in Conductivity due to scale. Per cent.
1	trace	hard, dense	9.1
2	.02	hard	2.02
3	.033	soft	4.3
4	.033	very hard	3.5
5	.038	medium	4.03
6	.04	soft	6.82
7	.04	hard, dense	3.07
8	.042	very soft	9.54
9	.047	hard	2.75
10	.065	medium	2.39
11	.07	soft	2.38
12	.07	hard	4.43
13	.085	soft	19.0
14	.089	very soft	4.95
15	.11	hard	16.73
16	.13	hard, dense	6.75

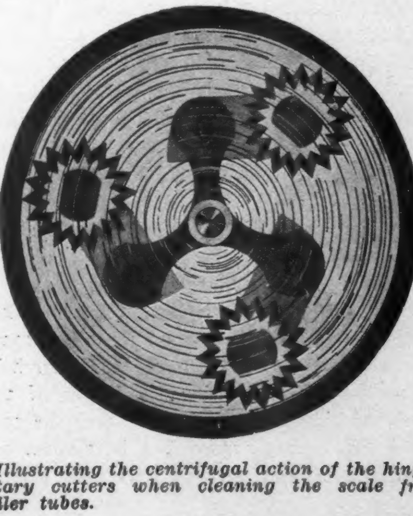
It is important that the scale be completely removed and that the operation be performed without injury to the tubes. The measure of scale which may be tolerated without inducing breakdown or disaster—quite apart from the question of fuel wastage—is determined by the type of boiler and the working pressures carried normally.

The fire-tube boiler is generally of a low-pressure class, while the water-tube boiler is designed to generate steam rapidly and at considerably higher pressure. Again, the fire-tube boiler carries a larger quantity of water than its water-tube competitor, and at the most efficient rate of evaporation the first will convert this water into steam in the course of an hour while the latter pattern of generator will evaporate all of its water content within a period of ten minutes or so. In the fire-tube boiler the water surrounds an aggregation of tubes through which the flame and hot gases from the fuel pass on their way to the smokestack, and, therefore, the smaller area, i. e., the interior, of these metal conduits is exposed immediately to the heat while the outside and bigger area is in touch with the water which absorbs this heat in the production of steam. As a result, the large volume of water in the fire-tube boiler is heated rather slowly.

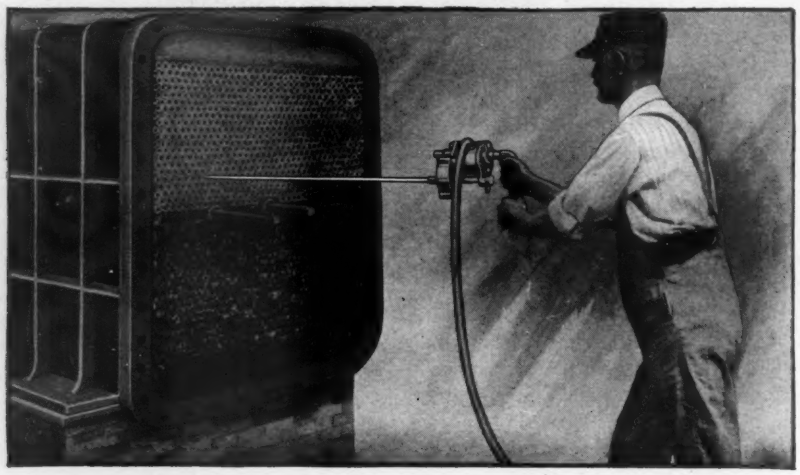
The water-tube boiler, on the other hand, functions in the reverse order. The engineer puts the water to be heated inside of the tubes and surrounds these pipes with a greater volume of flame and hot gases. He thus increases his heating surface; reduces the area in contact with the water; and, by this arrangement, brings about a very speedy conversion of the water into steam at high pressure. The steam so generated exerts a bursting stress—the opposite of the compressive action which takes place in the fire-tube boiler, and this pent-up force tends to rupture the tubes in the direction of least resistance. Now it so happens that boiler-tube scale is commonly deposited unevenly upon the metal surfaces; and where the scale is thinnest the heat acts most upon the metal and causes it to expand there more than elsewhere. In this way the tube may be burned through before the cooling action of the water comes into play, or the redhot tube may distend and burst under the impulse of its contained steam or pressure.

The foregoing picture should make it clear why it is highly desirable that boiler tubes be kept as clean as practicable not only in the name of security against failure or mishap, but as a safeguard against fuel sacrifices amounting annually to the equivalent of many millions of dollars. Cleaning boiler scale may be a tedious, vexatious, and rather costly undertaking or it may be accomplished rapidly, easily, and at a moderate outlay, according to the means employed. Various apparatus have been developed for this service. Some of these cleaners are driven hydraulically; others are actuated electrically, and a third class do their work under the impulse of either steam or compressed air. Up to a point each type has its virtues; but it is reasonably claimed by their advocates that the air-operated tools are the most adaptable and that they possess distinctive characteristics which put them at the forefront of the art.

To insure the widest satisfaction, a cleaner must do its work thoroughly, do it quickly with a minimum of labor, be uniform in its action, do no damage to the tubes or any other part of the boiler, and in no wise imperil the



Illustrating the centrifugal action of the hinged rotary cutters when cleaning the scale from boiler tubes.



Cleaning the small tubes of a surface condenser with an air-driven tool.

operative. This is a pretty big order, and yet cleaners have been devised which subscribe fully to these several conditions. Once more we have in these results evidence of the adaptability of compressed air.

Aside from the natural desire to protect an employee from harm there is the further incentive to safeguard him on account of the obligations imposed upon the employer by the various workmen's compensation laws. While steam can do all that compressed air can do still there is the ever-present risk of a bursting hose, and this menace is aggravated when the tool is being used by an operator within a confined space. Further, the exhaust steam has to be taken care of and led far enough away from the point of action to obviate trouble. Again, the heat of a steam-filled hose annoys or affects the worker, and agreeably to the measure of this action his performance is slowed up. Steam is objectionable for another reason: it carries off the oil in the moving parts and adds just that much more to the cost of operation. Finally, the steam heats the enveloping boiler tube and causes it to expand—especially in a longitudinal direction. The force exerted by the expanding tube may be sufficient to crack the header, particularly if the latter is made of cast iron. This tendency is all the more pronounced when the neighboring boiler tubes are cold.

Up to a point, the electrically-driven cleaner answers well, but its shortcomings cannot be ignored. First, the operating current may be either deadly or damaging if short circuited by any rupture of the cable insulation; next, where the whole of the cleaner unit has to make its way through the length of a tube, it is not feasible to produce a self-contained electric motor, within the diameter available, of sufficient power to do the work properly and to meet the changing conditions with which it may have to contend. If the tool should jam, the motor may break its shaft, burn out, or, owing to its inertia and positiveness, injure the tube. Should the electric cleaner on the other hand, be of a type in which the motor is always held outside the tube, then there is danger of the motor "kicking" vigorously whenever the tool jams. The operator may thus be thrown off his balance and fall, perhaps from some height. Because of its inability to adjust itself to circumstances—temper its action, so to speak, the electrically-impelled cleaner is not perfectly suited to deal with various apparatus fitted with tubes of brass or copper.

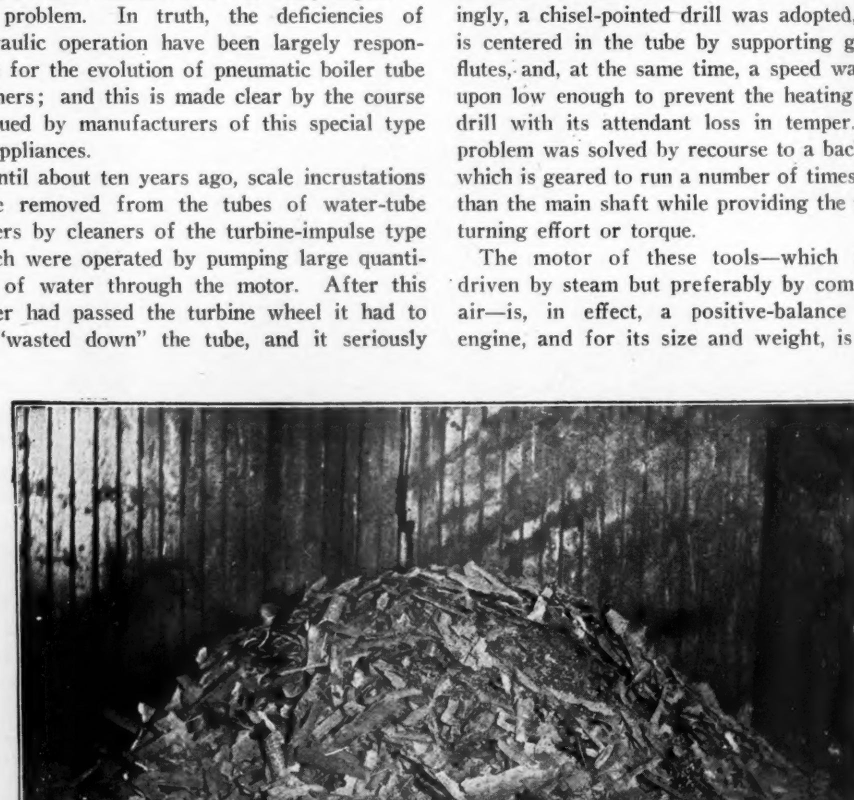
At first glance, it would seem that the hydraulically-actuated cleaner has none of the weaknesses or faults attributed to the steam or the electrically-driven cleaners. Certainly, the use of water involves no risk of scalding, burning, or electrocution. Even so, the impulse water must be got rid of; and the disposal of this exhaust is not the only aspect of the problem. In truth, the deficiencies of hydraulic operation have been largely responsible for the evolution of pneumatic boiler tube cleaners; and this is made clear by the course pursued by manufacturers of this special type of appliances.

Until about ten years ago, scale incrustations were removed from the tubes of water-tube boilers by cleaners of the turbine-impulse type which were operated by pumping large quantities of water through the motor. After this water had passed the turbine wheel it had to be "wasted down" the tube, and it seriously interfered with the efficiency of the scale removing tools which, of course, had to be advanced ahead of the motor. In search for better devices, cleaners capable of being driven by compressed air were designed, and the success in this departure became the basis of the typically modern cleaner. In this type of apparatus the exhausted compressed air, instead of proving a handicap as the discharged water had been, was effectively employed in assisting to clear out the tubes.

One type of these machines is equipped with a motor small enough to enter into and pass through a boiler tube; and the cleaner is controlled by the hose which conducts the impulse fluid to the motor. The rotary shaft has an extension at the forward end of the motor and to this the scale-removing fittings are attached in order to relieve the cutting mechanism of the rush of water which was characteristic of hydraulically-driven apparatus, for the purpose of being free to work on the scale without hindrance. As a consequence it is claimed they deal with a job in a fraction of the time formerly required.

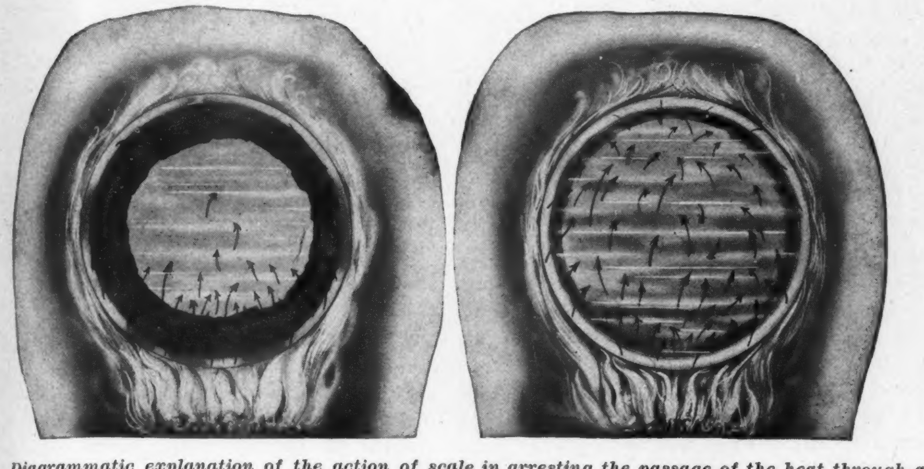
Later another pattern of cleaner was developed suited to the small tubes in feed-water heaters, ammonia condensers, surface condensers, evaporators, etc. Inasmuch as the tubes of most of these auxiliaries are made of brass or soft copper, it was apparent that it would not be possible to use the earlier design of scale-removing heads even if the apparatus could be made of a size to fit into the tubes. Accordingly, a chisel-pointed drill was adopted, which is centered in the tube by supporting guiding-flutes, and, at the same time, a speed was fixed upon low enough to prevent the heating of the drill with its attendant loss in temper. This problem was solved by recourse to a back shaft which is geared to run a number of times slower than the main shaft while providing the needful turning effort or torque.

The motor of these tools—which can be driven by steam but preferably by compressed air—is, in effect, a positive-balance rotary engine, and for its size and weight, is excep-



Photos, Courtesy, Roto Company.

The scale removed by air-driven cleaner from boiler tubes after they were supposed to have been cleaned by another apparatus.



Diagrammatic explanation of the action of scale in arresting the passage of the heat through a boiler tube and the converse when the tube is clean. One entails fuel loss and the other insures the effective use of the heat units.

ionally powerful. The makers of these devices say that because of this the motor is peculiarly adapted to tube-cleaning service in which the actual work is performed by a sustained centrifugal force delivered through expanding or tumbling heads. However, it is also claimed that the motors develop but little inertia or fly-wheel effect; and if the cleaning head jams or sticks the motor stops instantly so that there is no danger of cutting or damaging the softest of tubes. The motors are made to operate in straight or curved tubes which range in diameter from one and one-half to four inches; and their speed of revolution varies agreeably to the duty demanded of them. Special tools are built for tubes up to ten inches in diameter. When dealing with a heavily-scaled tube, the worker holds the cutting head firmly against the scale, and this action reduces the rotary velocity—the consumption of air being cut down proportionately. While removing heavy and hard scale rapidly, four-inch cleaners require an air supply of 35 cubic feet per minute at a pressure of 60 pounds. The main characteristic of an effective cleaner is that it must be made to fit the tube snugly and therefore cannot be pushed forward and through until all of the scale is disposed of. This feature will insure thoroughness and guarantee a condition within the tube that will make the most of the B. T. U.'s in raising steam. It is desirable that water be used freely to wash back loosened scale inasmuch as water will not injure motors of the sort in question.

So far, we have considered tools intended only for getting rid of scale within tubes. The same air-driven cleaners can be employed successfully in clearing away external incrustations, etc. This is done by using a rotary vibrating head, which delivers to the inside of a tube a succession of light, glancing blows. The vibration set up is not a shaking or swaying of the tube, but, instead, a slight momentary change in circular form such as that produced in striking a bell. This flexure serves to crack the enveloping scale or deposit and to cause it to crumble and fall off. The "weaving" tangential blows do not have a hammer effect; and it is claimed that they will not expand the tube; start the weld to leaking, or promote other injuries.

Air-operated apparatus of the kinds described are working wonders in boiler-room economies; for it has been demonstrated repeatedly that they can increase boiler efficiency anywhere from two to six per cent.; cut down the consumption of coal from two and a half to ten per cent.; minimize boiler repairs, and so reduce the time of cleaning that boilers may be speedily returned to service. Finally, because of the sureness, thoroughness, and rapidity of performance, these tools rob tube cleaning of its drudgery and put a premium upon frequent scale removal. This field of application is another illustration of the usefulness and the flexibility of compressed air as a motive medium.

DISCOVER CAUSE OF IGNITION OF ESCAPING HYDROGEN

THERE HAVE been so many cases of spontaneous ignition of hydrogen gas when charging balloons that an investigation has been carried on to determine the cause. According to a recent article in *Popular Mechanics,* various experiments were performed, such as allowing the gas to escape under pressure through different kinds of orifices, to determine if friction were responsible for ignition, but these experiments gave negative results. Finally, by observing in the dark a jet of hydrogen escaping through a pipe flange, it was found that a brush discharge of static electricity was plainly visible. When the pipe was tapped, to stir up the dust, an explosion occurred. From the investigation it would seem that the spontaneous ignition was due to the friction between the hydrogen and the dust of iron rust and to the brush discharge of static electricity from the electrified particles.

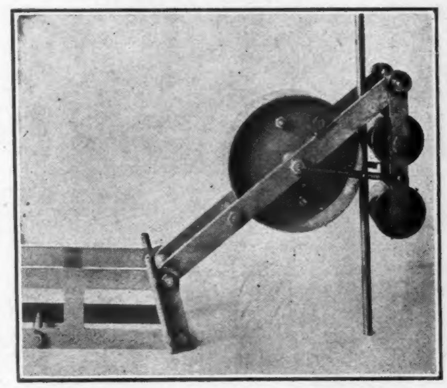
THE RAILROADS AND THE METRIC SYSTEM

A QUESTION sent out by the American Railroad Association concerning the adoption of the metric system of weights and measures brought replies from 61 railroads, eight of which were favorable, twelve were favorable if the system should be adopted by the U. S. Government and 41 were opposed.

DEEP WELL GAGING MACHINE

THE DEPTHS of oil wells or other subterranean borings may now be determined with mechanical precision by use of a deep-well gaging machine recently designed by C. E. Van Orstrand, physical geologist of the U. S. Geological Survey. The truism that necessity is the mother of invention again reasserts itself. The quandary of how to obtain the temperatures of deep wells spurred the inventor to marshall mechanical ingenuity, resulting in the device about to be described.

The apparatus consists of a wheel with a flat circumference two and one-half inches in width. The wheel is mounted on two parallel bars. The sand-line is clutched against this wheel by means of a couple of idlers. The latter may be of any convenient diameter, their pulling force towards the major wheel being exerted by spiral springs. The depths of wells being measured are recorded in feet by use of a revolution counter.



Deep well gaging machine.

This depth recorder, as illustrated in this photograph, is mounted on a steel frame. The needs of a driller or oil-field superintendent, however, may suggest the advisability of attaching the measuring instrument by steel cables to oil-well machinery above the apparatus and to the floor beneath same. The adaptability of the invention to the practical needs of drillers and oil-field superintendents remains to be determined.

Preliminary tests, however, in determining the temperatures of deep wells have demonstrated the promising value of the instrument. It has been successfully employed in measuring the depths to which thermometers have been lowered in deep wells of the United States. Among these being the deepest well in the world, at Fairmont, West Virginia, which penetrates a depth of 7,579 feet.

LONG STEEL COLUMNS EFFECT SAVING IN BUILDING

IN THE erection of a five-story office building in California recently, the use of long steel columns above the second floor resulted in a considerable saving in the time of erection, according to *Popular Mechanics.* The columns used were standard commercial 60-ft. lengths, and while heavier than necessary for the upper stories, the extra cost was offset by the saving in shop cost and erecting time.

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EDITORIALS

ACCIDENTAL ACCIDENTS

THE DEFINITION and the scope of application of the word "accident" would seem to be much in need of revision. Very often accidents, so called, are far from being accidental and really two words of widely different weight and significance are needed in the interest of truth and accuracy and also in locating responsibilities.

As we loosely talk, and as glib newspaper writers are in the habit of putting it, any occurrence, if it be not too big, like an earthquake or a sweeping conflagration, no matter how it may be caused, if attended by serious or fatal consequences, is customarily called an accident, but for an accident to be truly accidental it should be sudden and unexpected and brought about by conditions or agencies which have not been foreseen or could not have been controlled or prevented. Following our definition, an accident cannot be correctly designated as such until after the event. An accident which may be correctly reported as such may have been deliberately planned to occur, as train wreckers may cause what to them is anything but accidental, while to the victims it is an accident of the strictest definition. An accident truly accidental all through must be the result of unexpected or unpreventable causes or of unusual coincidences.

It is a coincidence of too frequent occurrence for an auto or other vehicle and a speeding railroad train to be at the same point at the same moment, and everybody would speak of the smash-up as an accident, which certainly in nine cases out of ten it would not be. But the smashed auto is only typical of what goes on everywhere. We ignore the well-known conditions of safety and we constantly and, more or less deliberately, take the chances, but we cannot dodge the consequences—all the time. The largest of our lists of accidents is of those which are not accidental and we must not go outside of the industry in which we are most interested to find them.

Compressed air in these days is quite busy in almost every line of industry, and normally it does its work without attracting special attention since the novelty of it has worn off. Occasionally, however, but with decreasing frequency notwithstanding the increase and spread of its business, the attention of the public is for the moment turned toward it by the occurrence of some accident, usually an explosion, and sometimes a serious one, and the good name of compressed air suffers accordingly. Of compressed air "accidents" it may be said perhaps more truly than of any others that they are not accidental but are the inevitable result of conditions or combinations of conditions easily ascertainable and avoidable. Taking chances with compressed air is not exempt from its consequences any more than any other kind of gambling.

If an air receiver explodes through actual weakness under ordinary working pressures there surely is no mystery about it. Both the strength and the condition of the materials and the actual pressure carried can be known with practical certainty and it is possible to fix with equal certainty that prescribed limits shall not be passed, thus, with a sufficient factor of safety, making such explosions practically impossible.

An explosion, generally much more serious in effect, which results from the formation of an explosive mixture of some volatilized constituent of the lubricating oil with the body of compressed air and then the ignition or firing off of the charge is no more an occurrence by chance than the other and should not be regarded as in any way mysterious. When an explosion of this character occurs, an ignition explosion, and it is assumed to be merely a static pressure explosion and investigations, after the event, are conducted upon this basis showing adequate strength of material and strict control of pressures which of course are unsatisfactory, then the compressed air "mysteries" are invoked. This is of too frequent occurrence. The ignition explosions should be recognized as such and then all mystery as to the cause at once disappears. Improper oil or, more frequently, too much oil and neglect of frequent inspection of valves and connections are sufficient explanations. It is not worth while to mention here the theory of the leaky discharge valve as that, if contributory, is entirely covered by the preceding.

Ignorance of the civil law excuses no one, and ignorance or the ignoring of physical law will not avert catastrophe.—*R.*

BIG BUSINESS AND THE STEEL CORPORATION

IT IS an old saying, attributable to Mr. CARNEGIE, that the steel business is either a feast or a famine. Before the organization of the United States Steel Corporation the effect of a panic or crisis in business usually resulted in paralysis among the steel mills and in failures in the industry. The influence of this upon the whole business of the country was very harmful because of the widespread ramifications of the steel industry. It resulted in a large volume of unemployment, in distress in the districts where mills exist, and it had its effect upon practically all lines of business, not only in the immediate vicinity of the mills but throughout the country.

We have recently passed through a period of extraordinary deflation. Prices have fallen rapidly, business was paralyzed, failures occurred in banks and in industrial organizations, and while the steel business became depressed, reaching a condition as low as 30 per cent of capacity, yet there have been no failures in the industry of serious consequence, and the recovery over a period of only a year and a half has been remarkable. This recovery has helped very materially in carrying the business of the country with it.

One naturally looks for a reason for this. The answer seems to be in the existence of the United States Steel Corporation, a powerful stabilizing influence, comparable in its effects with the Federal Reserve System in finance. The reserve power of this corporation, together with its exceptional management and economic position to produce at low cost, has enabled it to withstand the storm. Just as a large oak in the forest will resist gales, while smaller trees succumb, so has the Steel Corporation stood as a bulwark during recent trying times. We here have an illustration,—in fact a proof, that big business well managed, and having due consideration for its responsibilities in the public interest, is not a menace but it is of real public service.

THE BUILDING INDUSTRY AND PROSPERITY

WHILE THERE are many influences which have brought about the recent upturn in business, one of the most effective has been the boom in the building industry. During the month of April in 27 states contracts were awarded calling for building expenditures in excess of 353 million dollars.

Another influence of a smaller nature has been the large volume of municipal and road improvements. Money spent upon buildings and municipal and road improvements is not money wasted. It represents the use of capital in creating economic capital assets in adding to the wealth of the United States. While this is going on the buying power of the country is materially increased, labor is employed, materials are produced and business in many lines is stimulated to helpful activities.

During the War, when the governments of the world went into all markets and purchased billions of dollars worth of material, it created an effective stimulus which made business good, increasing the price of labor and of products. Such a situation, however, produces an inevitable reaction. The things purchased did not result in adding to the wealth of the country or in producing capital assets. They were destroyed, but the principle of stimulating activity through large buying power was there just as we now see its effects in building municipal and road improvements.

ENGINEERING CO-OPERATION

COMPRESSED AIR MAGAZINE has ever been a consistent advocate of coöperation between engineering societies and institutions, the world over. It has more than once advanced the thought that the greatest progress could never be made until engineers of all nations were brought into a close contact which would ensure an established harmony, a free and rapid exchange of ideas and of methods of improved practice.

The engineer, more than the man of any other profession, is international. The physician or the attorney, seldom ventures beyond his established habitat. The engineer, be his country what it may, is here, there and everywhere. One finds an American engineer in charge of great works in England and at the same time a British engineer (why are so many of them Scots?) at work in Peru; a Chinese engineer in Russia, a Japanese engineer in the Bermuda Islands, an American, a Frenchman, an Italian, a Spaniard and a Scotchman, all associated on the same job in far-away India.

It is therefore, with pleasure that COMPRESSED AIR MAGAZINE records the recent movement for the closest sort of coöperation between engineering institutions in Great Britain and France. There recently has been formed a British Section of the Société des Ingénieurs Civils de France. It is an excellent plan and we hope to see it grow, until it covers most of the globe.

This British section of the French society consists exclusively of engineers who have been elected members of the French society, all of whom become and remain members of it while a resident in any part of the British Empire, without formality or financial responsibility. Its essential objects are to establish closer relations between such members, but also generally, to encourage professional and friendly intercourse between French and British engineers, and to exchange information.

At the first meeting of the British section it was suggested that its objects would be furthered by drawing as many members as possible of British engineering societies into the ranks of the French society, and by working for the recruiting of French engineers as members of British engineering institutions.

The British section now possesses about three times as many members as it had when it was formed, but an obstacle that prevents many young French engineers from joining the British institutions is that the qualifications for associate membership usually include the passing of examinations or the possession of an approved diploma or certificate giving exemption from examination.

Arrangements have been made also by the British section of the French Society with engineering companies in Lorraine to accept a few British engineering students for periods of three months during summers so that they may gain the experience of French engineering practice. That is an excellent thing. We would like to see numbers of British and French engineering students—and engineering students of all nationalities so received in the United States. Equally, we should like to see large numbers of our young engineering talent going abroad, small delegations to every country, year after year. We should like to see a similar exchange between all other countries. So, shortly, engineers of all lands, could proudly say that theirs was in whole truth an international brotherhood dedicated to the progress of civilization.

Compressed air practice would surely gain immeasurably by such a programme.

B. K. R.

ENGINEERING NEWS-RECORD AND ST. LAWRENCE SEAWAY

WHATEVER MAY be said about the proposed St. Lawrence seaway no one doubts that it is a great engineering undertaking,—one involving civil, mining, mechanical and electrical engineering. It calls for the development and utilization of the forces of Nature for the benefit of the human race. This is one of the definitions of engineering.

There is nothing new about the engineering on the St. Lawrence. It is simply doing over again what was done on the Soo, what has been done at the Welland Canal, at Panama, and at many other places. No engineer with an unprejudiced mind, competent to judge, will doubt that the St. Lawrence seaway can be built. No engineer who has been over the ground will doubt that it can be built at reasonable cost.

It is surprising, therefore, to see that our leading engineering paper—the *News-Record* —should say editorially: "The best thing Congress could do during the diplomatic discussions of a treaty would be to authorize an unprejudiced group of economists, shipping men and engineers to report on the possibilities and practicabilities of the waterway." An unprejudiced commission, representing the United States and Canada, has held hearings all over the United States, covering a period of nearly two years, and has made a unanimously favorable report. Two engineers, one from Canada and the other from the United States, both men of standing, have made a favorable report. What more do we want? We fear that the editor of the *News-Record* is so much surrounded by the atmosphere of opposition in New York that his engineering judgment and influence have become distorted and that he is simply following the argument of those who want to kill the project by creating delay. We had heretofore looked up to the *News-Record* as representing all the people and not a section. If we wait until all the objections to a movement are answered no progress will ever be made in the world. It takes vision and nerve to take a step in advance, as this St. Lawrence seaway is. If we had listened to the experts against the Panama Canal lock system the canal would not be in use today. If Captain EADS had waited until all the experts approved his jetty system the mouth of the Mississippi would still be blocked.

DEFLATION IN FINANCE COMPARED WITH 1893

THE UNITED STATES reached the peak of inflation in 1920. It is interesting to note that the total liquidation in bank loans covering a period of about twelve months has been between five and six billions of dollars or about sixteen per cent of an approximate total in bank credits of about thirty billions of dollars. Following the panic of 1893 the deflation of bank loans extended over a period of about twelve months and reached a decline of about fifteen per cent.

There is one notable difference, however, between the '93 panic and the recent depression. Following the fall in '93 there was a drain of gold from this country, while recently, and in fact almost throughout the entire period of deflation, there has been an inflow of gold into the United States. This has amounted to nearly a billion dollars.

The lesson from this is that in olden times, before the Federal Reserve System was established, the banks, during deflation, were not in a position to expand credits because of the lack of gold as a basis, while now such expansion might easily be effected by the system of rediscounts at the Federal Reserve Bank. The potential capacity of the banks of the United States today to expand credits goes beyond the requirements of industry. The importance of having the capacity to expand cannot be overestimated in case business conditions call for capital to finance activities. The Federal Reserve System not only affords an opportunity to help the banks to so expand, but they are in a position also to create the currency that would be required for such expansion.

If it is true, as some believe, that the panic of 1893 lasted four years because of the limited credit capacity in the country, then we may hope that the present conditions of improvement might go on, because from the point of finance the foundations on which business activities can build are ample and secure.

HELICOPTER PROGRESS

THE PROBLEM of the helicopter is an enticing one, and we scarcely need the assurances which come to us from different sources that persevering inventors and experimenters, not forgetting their venturous financial backers, are working industriously toward the development of apparatus of this specific type, and that at least sufficient success is resulting to continually urge them onward. Preliminary details of progress are of little interest to the outsider at the present stage. As with the airplane, privacy will be impossible in the climax of accomplishment, and that is not yet. It may be expected that com-

plete practical success in the essentials sought: unassisted vertical ascent to any height desired, then a controlled and directed lateral flight and a safe alighting within precisely located and narrowly limited space, will be announced, or, rather, will announce itself quite suddenly, for the simple reason that immediate and complete publicity will be unavoidable.

It is not to be hastily assumed that the apparatus sought, in its ultimate development, will surpass the performance of the airplane of the day in speed and reliability of actual flight and the carrying of passengers or of privileged freight. That achievement is already sufficiently wonderful. The ultimate preference will be determined rather by the complete mastery of the conditions of ascent and descent. The failure to satisfy the imperative requirement in this particular must continue to hold back the airplane as it is at present, and it is not unwarrantably visionary to assume that the problem will ultimately be solved as completely as have been the others presumably more difficult, whether it be accomplished by the helicopter as we now have it in mind or by some other happy combination of devices.

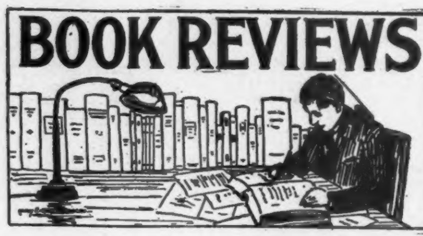
With the art of human flight becoming daily more safe and sure we are warranted in attempting to forecast the opportunities of the future and to prepare for the full appropriation of them. To find suitable places for starting and for landing need trouble us no more and least of all in our crowded city areas. The most obvious and natural home for the human flier, as for the pigeon, is upon the roof. The roofs are generally ready everywhere and with a little thought for the convenience of the fliers may be easily adapted to perfectly fit the simple requirements, and if the fliers in time increase in numbers like the automobile they will be more comfortably taken care of and more perfectly independent. R.

RADIO SUGGESTED FOR MINE RESCUE WORK

THE POSSIBILITIES of wireless telephone in connection with mine-safety and mine-rescue work has been suggested to the United States Bureau of Mines. The suggestion has been made that, by use of high-power sending stations at the bureau's experiment stations at Pittsburgh, Pa., and Salt Lake City, Utah, mesages could be broadcasted to the various mine safety offices and cars stationed throughout the country. Mine-safety programs and instructions could be sent to the various chapters of the Joseph A. Holmes Safety Association, located in the different mining centers. Aerials have been installed on trains in Germany, and it is pointed out that it would be entirely possible to build similar aerials on the mine-rescue cars of the Bureau of Mines. Field engineers of the bureau have reported that the radio is already in wide use in the different mining centers.

Exports of iron and steel from the United States during April, according to figures compiled by the Iron & Steel Division of the Department of Commerce, amounted to 200,733 long tons.

BOOK REVIEWS



HANDBOOK OF CHEMISTRY AND PHYSICS, by Charles D. Hodgman, M. S., assisted by Melville F. Coolbaugh, M. A., and Cornelius E. Senseman, M. A. Eighth Edition, 711 pages. The Chemical Rubber Company, Cleveland, Ohio, $3.00.

THIS HANDBOOK is a new and revised form which the authors present in one compact, easily portable volume, as a comprehensive reference book for use in the laboratory or classroom. While more complete and broader in scope than the reference material ordinarily found in the laboratory manual, it is still not a competitor of the many large and complete reference books already published, but fills a place not hitherto occupied by any other publication. The material included has been carefully selected by men of wide reputation of the Case School of Applied Design, and these gentlemen have been guided in their selections by the suggestions of more than a thousand members of high standing in the chemical and physical profession.

A large number of the tables are the result of compilations from various sources; the original authority or the source of information being stated where possible. A number of the "Smithsonian Tables" have been used without alteration. Two notable additions to this eighth edition are the new and enlarged numerical table and the complete and exceedingly convenient set of Metric-English and English-Metric conversion tables.

ANNUAL REPORT OF THE SMITHSONIAN INSTITUTE, a summary of the operations, expenditures, and condition of the Institute for the year ending 1920. The Government Printing Office, Washington, D. C.,

THOSE INTERESTED in research, exploration, natural science and in the diffusion of knowledge in general will find the present volume of very great interest, containing much valuable information in many fields of investigation. The scope of the operations includes data on geological exploration, astrophysics, meteorology, mineralogy, agriculture, biology and botany.

There is also included brief descriptions of a number of expeditions sent out by the Institute during the year as follows: Geological exploration in the Canadian Rockies, the Collins-Garner French Congo expedition for the collection of biological material, a botanical exploration in Jamaica and several other investigations made by expeditions in Africa, Haiti, Santo Domingo Glacier National Park in Montana, British Guiana and the Far East.

This year witnessed the bringing together of a large war collection, made possible by the hearty co-operation of the War and Navy Departments. In addition to supplying the objects, the department transported the specimens without cost to the museum, performed the necessary mountings and in a great many instances detailed officers and men to assist in classification work. These collections illustrate the work of both branches of the service during the war.

American Research Chemicals—A compilation of research chemicals which was prepared by Clarence J. West for the Committee on Research Chemicals of the American Chemical Society and the Research Information Service of the National Research Council has just been issued in revised form as No. 35 of the "Reprint and Circular Series" of the National Research Council. The marked advance shown by the American chemical industry during the last few years is evidenced by the surprisingly large number of high grade chemicals listed in this publication as now purchasable from American manufacturers. The so-called "heavy chemicals" have been omitted because there are so many recognized manufacturers and dealers from whom they may be secured. For the same reason practically all inorganic salts are omitted.

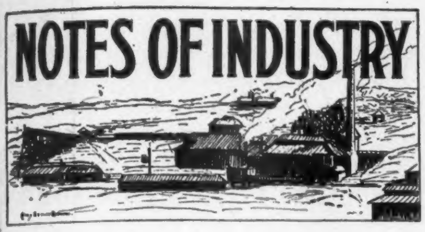
Nearly three hundred research chemicals not included in the first edition, have been added in this revised list. Many additions have also been made to the list of biological stains and indicators, while a list of dyes that have been carefully purified for use as vital stains has been added. The list of hydrogen ion indicators has been very much extended and a chart of these showing the hydrogen ion concentration range added.

It is recognized that the list may have shortcomings, and constructive criticisms and additions will be welcomed. Those interested in this booklet may secure a copy from the Research Information Service, National Research Council, Washington, D. C.

Mica, Serial, 2,357, Bureau of Mines, Washington, D. C., by Oliver Bowles, mineral technologist contains an interesting discussion of that group of minerals included in this general classification. Each variety is described according to physical and chemical properties and occurrence both in the United States and foreign countries. The various uses of the different varieties are numerous as well as the economic importance of the industry as a whole.

AIR-COOLED SUIT TO PROTECT WELDERS

The *Journal of the American Welding Society* briefly refers to an air-cooled suit recently invented and designed to protect the oxy-acetylene welder from the heat he is exposed to when doing heavy welding in confined spaces. The workman equipped with this device is protected from the heat by the circulation of air around his body. The air, which is supplied by a fan through a flexible tube, circulates through the mesh of the fabric of which the suit is made. In very hot work the helmet not only protects the head of the welder but also supplies fresh, cool air for breathing. The suit is assumed also to be a protection from poisonous gases and can be worn for several hours without discomfort.



At Canandaigua, N. Y., a 6-in. gas main 1800 ft. long has been found to be in good condition after a service of more than seventy years. Iron bands at the joints were badly rusted and some of them had to be renewed. The gas pressure is of course only a few inches of water.

Great strides toward standardization, particularly in the construction, metals, mining, and electrical industries of Belgium are indicated in a report from the Association Belge de Standardization which has just been received by the American Engineering Standards Committee, 29 West 39th Street, New York City.

The purpose of a new investigation, to be undertaken by the Bureau of Mines at Butte, Montana, is to study the flow of air in metal mines, especially with reference to frictional coefficients and resistance. The work, which will be done by Daniel Harrington, supervising mining engineer, and G. E. McElroy, technical examiner, will probably consume a year's time.

The removal of more than a million cubic yards of rock and sand in the dredging of a mooring basin and channel, is the announced intention of the government of the Bahama Islands. The basin will be 600 ft. square and 25 ft. below the depth of low-water level, while the channel will be approximately 5,600 ft. in length, at a depth of 25 to 27 ft., and will range from 250 to 400 ft. in width.

The annual convention of the National Association of Railway and Utilities Commissioners, composed of the members of the various state public service, railway and utility commissions, and also of the Interstate Commerce Commission of the United States, will be held beginning September 26th at Detroit, Michigan.

Orders for fabricated structural steel placed during April were almost equal to the capacity of fabricating firms, according to reports made to the Department of Commerce by firms comprising two-thirds of the fabricating capacity of the United States. Sales reported during April amounted to 115,247 tons by 75 firms having a capacity of 116,916 tons, or at the rate of 99 per cent. of capacity.

At the plant of the Western Electric Company, near Chicago, there is consumed each year approximately one-tenth of the total lead product of the United States. In 1921 the factory purchased 26,555 tons of the metal which was used for covering 6,700 miles of telephone cable.

The Conquistadores, when they seized the rich emerald mines of Colombia, forcing the native Indians to work them, suspected the existence of other mines. After a search of three years in Colombia, Christopher Dixon, engineer for the Colombian Emerald Syndicate, who arrived recently in this country, says he has located some of the ancient mines hidden from the profiteering Spaniards by the natives.

The emeralds of Colombia are the finest, but not the biggest, in the world, and the country produces more than all the rest of the world combined. The recently rediscovered mines, Mr. Dixon said, are about two and a half days' journey from Bogota. Mr. Dixon will stay here a month conferring with the heads of his company.

The *Berengaria*, formerly the *Imperator*, recently was successfully drydocked at Southampton. The length of the vessel at the water line is 896 feet and her beam 98 ft. 9 in. while the dock has an over-all length of 897 ft. 3 in. and an entrance width of 100 feet.

Among the manufacturing industries of the Southern states of the Union the ice business has risen in 22 years from the twentieth to the sixth place.

Experiments are being carried out by the Colombo municipality in the use of rubber as a road-surface dressing, says Consul Vance, Colombo, in a recent report to the Department of Commerce. The dressing, which is the invention of a Ceylon rubber planter, is now being used on a portion of Darley road, which is one of the most used thoroughfares in Colombo.

At the Pittsburgh, Pa., experiment station of the Bureau of Mines, tests will be made to determine the pressure required to force air at various rates through various thicknesses of nine sizes of anthracite. The information is to be used in estimating the relative draft required to burn these sizes. C. E. Augustine, assistant engineer, has been assigned to the work.

There are at the present time more American automobiles in Spain than all other foreign makes combined, says Commercial Attache Charles H. Cunningham, Madrid, in a report to the Department of Commerce. The American car is especially adapted to conditions in Spain and this fact is well recognized by the Spanish people. The leading competitor of the United States in the Spanish market is France, while there is little danger from the much heralded competition of Germany and Italy.

COPPER COMPANY SEVEN CENTURIES OLD

ON THE letterheads of the Great Copper Mountain Mining Co., Inc., of Sweden, one reads this astounding legend: "Founded in 1225."

Mining and smelting were carried on near Falun, Sweden, 700 years ago and prospered to the extent that in the 17th century Sweden led all countries in copper production. (True, the entire world's consumption for the year 1655 was only 3,453 tons, the output of the Swedish mines, today controlled by the above named company). A charter dated 1347 specifies certain privileges that the miners were to enjoy.

"But the company's records go back farther," according to a recent article in the *Swedish-American Trade Journal* and reprinted in *The Yellow Strand*. "A letter dated 1288 shows that a certain Bishop Peder acquired a one-eighth share of the Falun mine by trade." Mining of the ore, smelting, and manufacturing copper products were conducted separately. Until 1716 mining was done by individuals exercising their rights as "par" (share) holders. The ore was also smelted privately in picturesque little huts, this practice continuing until 1862. The company took over the manufacturing end as early as 1641.

The Falun Copper Mine has yielded 35 to 40 million tons of ore, from which has been extracted 500,000 tons of copper.

The Daily Sketch, London.

WHEN THE COMPRESSED AIR PAVING BREAKER GETS BUSY.

PNEUMATIC TOOLS BREAK GROUND FOR SIGNAL TOWER

THE ORIGINAL temporary signal towers, still in use on Fifth Avenue, New York, have proved so successful in regulating traffic, preventing accidents and saving time that the Fifth Avenue Association recently decided to lose no more time in having new permanent towers installed, not only to facilitate the increased traffic capacity of the avenue and the greater measure of safety for moving vehicles but also to add to the artistic attractiveness of this well known thoroughfare.

The five original temporary towers were presented to the city on March 4, 1920, by Dr. John H. Harriss, Deputy Police Commissioner and Director of the Fifth Avenue Association, who was largely responsible for introducing this system of synchronized traffic control.

The new towers will be seven in number, and will be erected at 14th, 26th, 34th, 38th, 42nd, 50th, and 57th Streets thereby extending the tower system of traffic control from Washington Square north to 60th Street.

New Fifth Avenue traffic signal tower.

Pneumatic paving breakers being used to break ground for the new master traffic-control tower.

The accompanying illustration shows C. Stanley Mitchell, chairman, Traffic Towers Committee of the Fifth Avenue Association and vice president, Chatham & Phenix National Bank and the Hon. Grover A. Whalen, Commissioner of Plant and Structures, in the foreground breaking ground for the master control tower at 42nd Street and Fifth Avenue, one of the busiest corners in the world. Each of these gentlemen is using an Ingersoll-Rand pneumatic paving breaker which will be used for excavating the foundations for the towers. The pneumatic paving breaker is peculiarly adapted for this kind of work, which must be completed within a minimum of time because of the great volume of traffic requiring rapid movement. The foundations are of a heavy and extensive character in order to sustain the bronze superstructure which will be 23 feet in height with a granite base.

These pneumatic paving breakers have become a more or less familiar sight in the streets of many cities especially London, New York, San Francisco and many other American municipalities. One reason for this rapidly expanding application in all sorts of street repair work is because of the simplicity of equipment and the speed with which the work is performed that the street traffic is impeded as little as possible, whereas the time required formerly by hand methods required the cutting off of areas of space and arteries of transportation with all the attending annoyance and considerable loss in money and time. Consequently there was no question about putting these tools to work excavating at New York's busiest corner.

The towers will be provided with a single lens equipped with a changeable reflector to throw the red, green and white rays for the regulation of traffic movement. Electrically synchronized clocks will be placed in the north and south face of each tower. Each structure will be surrounded by an isle of safety.

The design for the new permanent towers was selected as the result of a competition conducted under the rules of the American Institute of Architects. The winning one was selected out of 130 designs submitted and was the work of Joseph H. Freedlander, an architect of international fame. The cost of erection of these artistic and beautiful towers will be about $100,000, the amount to be raised by subscription among the members of the Fifth Avenue Association, Inc., and other public spirited citizens.

The contract has been let to the John Polachek Bronze and Iron Co., of Brooklyn, and calls for delivery of the completed towers on October 15th.

The foundations are being built by the Department of Plant and Structures under personal direction of Commissioner Whalen and Chief Engineer Byrne.

DETERMINING RELATIVE COMFORT OF MINE WORKINGS

BY MEANS of the katathermometer, an instrument devised by Dr. Leonard Hill, an eminent English physiologist, an exact numerical index of the relative comfort of a working place may be obtained, free from any personal equation, as determined by the temperature, pressure, relative humidity, and motion of the air of the place, states the U. S. Bureau of Mines, in Serial 2355, just issued. The instrument cannot take into consideration such vital elements affecting comfort as chemical impurity of air and presence of various kinds and quantities of dust, both of which may become determining factors in comfort of underground workers; nor measure the effect of undue noise, cramped positions, etc., which also may be important items in determining comfort of underground workers. Wet-bulb air temperature (obtained with a sling psychrometer) and air motion are, however, the controlling factors of comfort most often encountered both in mines and elsewhere, and the substitution of "kata" cooling powers for the limiting wet-bulb temperatures now employed in comfort standards will no doubt take place as the instrument becomes more widely used, since its degree of sensitiveness is such that it indicates the effect of otherwise imperceptible air motion, whether from only one direction or from eddy currents.

WET ROPE KINKS

We think of a rope as typical of pliability and yet it has insistences of its own. Every washwoman knows that her clothesline shrinks and grows tight—sometimes too tight—when wet, while a leather belt gets slack under similar conditions. Paper also tells of weather conditions by bagging under excessive humidity. The most curious thing about a wet rope is that it is not only shorter but also has its tensile strength increased by the wetting. Mr. Fred A. Jenks, of the Plymouth Cordage Company says that "a new rope which has absorbed 50 per cent. of its own weight of water will be increased in strength approximately ten per cent." The adhesive friction of a rope is increased much more than this by wetting.

Mr. John F. Schurch has been elected a Vice-President of Manning, Maxwell & Moore, Inc., and on June 1st took charge of their western sales, with headquarters at the Company's Chicago Office, 27-29 North Jefferson St., Chicago.

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